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AGRICULTURAL ENGINEERING

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A British View of American Rural Electrification

SOME stimulating observations on rural electrification in America have been made by our recent visitor and British contemporary, Mr. R. Borlase Matthews, agricultural and electrical engineer.

He believes that in ten years America will be well ahead of the rest of the world in rural electrification. This is with due recognition and exception of the areas which extensive agriculture places beyond the reach of central station service.

He finds the service rates favorable to increased farm use of electricity, except for cases where there are "installed motor" restrictions.

Electric motors, motor use, and current for motors, by the way, seem to be the most important features of further progress in rural electrification, from his viewpoint.

Looking favorably upon the tendency of farmers to use more individual drive motors, he points out that the labor saving is worth while, even though each motor is used only a comparatively few hours per year. Incidentally, farm practice usually works most of the motors consecutively, in a series of operations, rather than simultaneously in parallel operations. This, says Mr. Matthews, "means that 'installed motor' ratings can be neglected as a basis of charging."

One handicap noted by Mr. Matthews, in his American tour, is the scarcity of farm equipment designed especially for electric drive and offered for sale complete with built-in or attached electric motor. Another is the prevalence on farm supply lines of single-phase rather than three-phase current. The lower first cost of three-phase motors; the less complicated load-balancing problem they involve; and their resulting load-building characteristics, would make three-phase lines a good investment, he believes. He also indicates that America will come to three-phase rural lines sooner or later, and that it would be more economical to make three-phase installations originally than change later.

Furthermore, Mr. Matthews calls for a special agricultural type of motor, with many of the characteristics of a mine motor; one that would be dampproof, and ready to run at the throw of a switch after any long period of disuse. And it should cost even less than the present three-phase, squirrel-cage motor, he adds.

Disappointed in the lack of American experiments in the use of electricity for field power, he minimizes the excuse that electricity cannot compete with cheap oil fuel on farms, and points out that electricity does compete successfully with oil engines on heavy power jobs in city factories.

Twelve motors per farm, on an average, is Mr. Matthews' idea of a reasonable goal in America for power load building. A building boom in America would create a shortage of farm labor, he adds, that would increase the need and demand for rural electrification.

Financially, Mr. Matthews indicates that proper electrification of a farm might increase the total capital investment by 25 per cent, but that it should also increase the net income by 5 per cent of the increased total investment.

Reiterating an experience of many American agricultural engineers, Mr. Matthews concludes "Both in Europe and America, I find that the number of electric motors installed on farms is always in proportion to the knowledge and enthusiasm of the rural electrification staff of the electricity supply undertaking. It is never sufficient to provide a supply of electricity to a farm. The farmer must be taught how and persuaded to use it."

Cost Finding as a Guide to Agricultural Engineering

IN line with his previous correspondence[1], the U. S. Bureau of Agricultural Engineering research on the engineering reorganization of farms[2], and other evident interest in farm operating efficiency, Arthur O. Fox (Hon. Mem. ASAE) has again called attention to the importance of farm cost finding.

An agricultural engineer experienced in the philosophy and factory methods of cost finding could, Mr. Fox believes, work out a simple cost data sheet for farms which any bright farmer, or his son or daughter, could understand and use with reasonable accuracy.

A few exceptional farmers have demonstrated the practical value of cost finding in farm operations. It seems reasonable to expect that their methods might be simplified, without any material loss of effectiveness, for application to small-scale operations by ordinary farmers.

It seems probably that individual machines and scientific methods of performing specific farm operations have been refined far beyond the refinement of their integration into specific farm operating and production programs. If so, this needed integration is, in fact, a technical frontier; a neglected phase of agricultural engineering; a major opportunity to help farmers help themselves.

Cost finding provides the only real criterion on which production equipment, methods, and operating schedules may be judged in their relation to the individual farm. It should further the application of engineering to agriculture by showing how, where, and to what extent engineered methods and equipment can be applied profitably. Agricultural engineers may use it vigorously and fearlessly in search of what it may reveal, whether that be irrefutable evidence of economic advantages claimed for power and machinery, or a series of limitations and disadvantages which should not be misrepresented to farmers.

Cost finding may well be looked at as the final testing procedure for engineering methods and equipment, and combinations thereof. It warrants attention as a guide to engineering development in the field of agricultural production. As an aid to progress in farm cost finding, AGRICULTURAL ENGINEERING will be glad to act as a clearing house for simple farm cost finding systems and ideas submitted, whether they are in practical use, experimental, or merely suggested for trial.

[1]"Cost Finding," AGRICULTURAL ENGINEERING, Vol 17, No 5 (May 1936), page 188.

[2]"The Engineering Reorganization of Farms," by N. A. Kessler, Vol 17, No 4 (April 1936), page 153.

Engineering Standards and Acceptance

THERE still remains a pardonable doubt among some guardians of the high technical and professional standing of the word "engineer," as to the qualification of college agricultural engineering departments to teach courses and develop graduates in keeping with their standards. We say "pardonable" for several reasons.

The desire to hold "engineering" and all that it symbolizes on a high plane is a worthy ideal. We would rather see agricultural engineers and agricultural engineering rise above all question of doubt as to their place in the engineering profession, than to see the true and accepted meaning of the world "engineering" lowered to accommodate a lesser standard of intellectual proficiency and achievement.

Multiple functions of college agricultural engineers and agricultural engineering departments tend to hide and minimize their engineering position and significance. The lack of definite, well-organized trades in the special fields of farm mechanics, farm plumbing, farm carpentry, and farm wiring, necessitates service functions in these fields by agricultural engineers. These necessary incidentals are sometimes more in evidence than the truly technical engineering work accomplished by the same men and departments. Essential service courses for agricultural students, and agricultural college administration in some cases, confuse the issue.

Small wonder that those engineers of older, established branches who have had little or no contact with agricultural engineers and their work, may doubt both the need and the existence of men who are essentially engineers, being so specialized in training and work as to warrant the name of "agricultural engineers." The natural presumption is that anyone who has spent much time studying agriculture must necessarily have neglected some fundamental points in the complicated and thorough technical discipline administered to aspiring young engineers.

Confusing elements in the position and work of agricultural engineers cannot be eliminated, but they can be explained and clarified for the benefit of anyone interested.

Agricultural engineering research can adhere easily and naturally to rigid engineering standards. Teaching in the professional courses aspires to develop the best possible engineers. Extension work in agricultural engineering can be, and generally is, carried out in an engineering manner of organization and performance. Service and extension courses are offered with definite instruction to the enrollees that such courses will not qualify them as agricultural engineers. These facts can and should be pointed out to the well-meaning doubting Thomases in the high calling of engineering.

Engineering is deeply analytical and creative. Use or application of the results of engineering is not necessarily so. Agricultural engineers are not trying to make every farmer an agricultural engineer, any more than automotive engineers would try to make every truck driver an automotive engineer. However, a farming enterprise may profit by engineering organization, maintenance of equipment, technical control and elimination of waste, in the same manner as the operation of a fleet of trucks, for example.

Engineering in agriculture, as in other activities, will continue to mean a high level of intellectual proficiency, applied to the same technical method of work used by engineers in older branches of the profession. Men applying the resulting equipment and methods in other capacities will not be classed as agricultural engineers, and their work will not be called agricultural engineering. When guardians of the word are enabled to feel confident of this, we believe they will not hesitate to accept agricultural engineers and professional agricultural engineering curricula as worthy standard bearers in the engineering profession.

The Spread of Engineering

MECHANIZATION, engineering progress, and refinement of methods, equipment, and products start near the consumer and work back through the process industries to the original producer of raw materials in field, forest and mine.

R. U. Blasingame, president of the American Society of Agricultural Engineers, brought out this point in addressing the North Atlantic Section of the Society at its last meeting. The thought helps clarify the position of agricultural engineering.

Though engineering, in its horizontal spread, reached agriculture some years ago, there still remain large sections of the industry which it has not reached to any great extent. There is still room for horizontal expansion within agriculture, to new units and fields of production.

The fact that agriculture has been reached and partially penetrated in the horizontal expansion of engineering, suggests added impetus to progress in the vertical direction of refinement of equipment, processes, and produce. Industries closest to the consumer naturally lead in this, too, as pointed out by Professor Blasingame. The implication, as we see it, is that agricultural engineers will be able to profit much by a close study of the experiences and developments of other engineers, in the refinement of engineering.

Horizontal expansion being in its final phase, however, it does not follow that agricultural engineering need necessarily lag behind engineering activities closer to the consumer, in their course of progress along the parallel vertical paths of refinement. While other engineers may be closer to the stimulus of consumer demand, agricultural engineers stand closest to those invigorating intangibles which have always made farmers the foundation of nations.

Machine Wanted

A MORE satisfactory device for removing hulls from tung nuts in the orchard, is reported to be a present major need in establishing the new American tung oil industry.

Development of this device is a job for some southern agricultural engineer. It is definitely a new piece of farm equipment that is wanted, to aid in the handling of a new southern farm crop. It is an example of one way in which agricultural engineers fit naturally into farm chemurgic progress.

Possibly one or more agricultural engineers are already working on the problem. At any rate, here is an opportunity.

Drying Seed Corn with Electricity

By F. W. Duffee

THE bin method of drying seed corn was developed at the Wisconsin Agricultural Experiment Station during 1926, for the purpose of making possible the commercial production of seed corn in Wisconsin, which is in the northern zone of the corn belt. Prior to this time, such seed corn as was produced commercially in the state was dried for the most part by mounting the ears one by one on or in some type of suspension unit or hanger, or by laying them on shelves or racks, and requiring a very large amount of hand labor, a large space, and a long drying period. Unless the air in the room was well agitated and kept at a rather high temperature, molds and other fungi would sometimes develop. This method was too expensive for extensive commercial production, hence the development of the bin method of drying. It is generally recognized that corn is very susceptible to climatic changes, especially the open, pollinated varieties. The best results are obtained from seed grown under similar climatic conditions, which usually means grown in the particular locality.

At the time of development of this drier, approximately 30 per cent of the commercial seed corn sold in Wisconsin was homegrown, and the balance of it was grown outside of the state. At the present time, these figures are approximately reversed, fully 70 per cent of the commercial seed corn being homegrown and 30 per cent imported. It may be interesting to observe here that for 1937, probably about 90 per cent of the commercial seed will be homegrown, in view of crop failures in the western areas.

In more recent years, the bin method of drying has spread rather rapidly through adjacent states, following the introduction of hybrid corn in those areas. The introduction of hybrid seed corn apparently has resulted in large-quantity production by a number of growers, and this, together with the higher per-bushel value of hybrid seed, has led them to adopt a surer and safer method of drying, to be sure of saving the more valuable crop and to control disease and other fungus organisms accurately and positively.

At the present time, there are 26 driers in Wisconsin, and the best information we can obtain indicates that there are 15 in Indiana, 10 in Ohio, 15 in Illinois, and 10 in Iowa.

About 75 per cent of the commercial seed corn produced in Wisconsin is now dried by this method, and about 15 per cent in a modified type of drier, which was developed for smaller producers. The balance is dried by various other methods, and represents small lots.

This method is intended for those who make a business of producing seed corn. There is one unit in Wisconsin with a seasonal capacity of 25,000 bu, another one with a capacity of 10,000 bu, and one each in Illinois and Indiana, that we know of, with a capacity of 20,000 bu per season. Plans and specifications are available on sizes ranging from 500 bu per year and upward.

How the Bin Drier Works. The usual plan is to install rows of bins on each side of a central air duct which is divided horizontally through the middle, giving an upper duct and a lower duct. The bins, which are usually 10 ft deep, have slatted floors approximately one foot above the tight floor. The corn is filled in on top of the slatted floor 7 to 8 ft deep. Suitable air ports serve to connect the space underneath the slatted floor with the lower air duct, and the free space above the corn with the upper air duct. Every 12-hr period, the flow of air through the corn is reversed by means of a simple valve between the fan and the air ducts. This reversal of the air flow is quite important in securing uniform drying.

The construction and operation of the drier are extremely simple, and, as I proceed with the discussion of the various specifications of the operation and equipment, I want to emphasize this particular point: It is not necessary in most cases to adhere strictly to the limits mentioned, but experience has indicated that these limits mentioned are desirable. This is particularly true in the matter of the recirculation of the used air from the bin. May I emphasize here before going further that it is important to avoid using temperatures that are too high, as this will definitely result in lowered germination.

The widespread success of the system, we believe, has been due in no small measure to the simplicity of construction and operation of the equipment, and to the elimination

Presented before the Rural Electric Division of the American Society of Agricultural Engineers at Chicago, Ill., December 4, 1936.

Author: Professor of agricultural engineering, University of Wisconsin. Mem. ASAE.

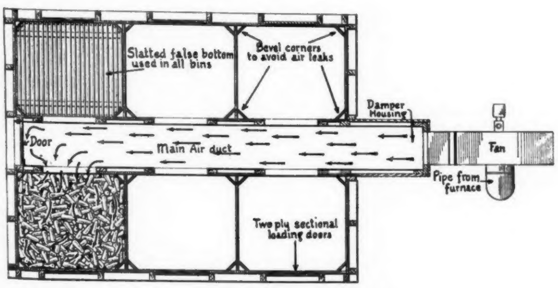

FIG. 1 ARRANGEMENT OF DRIER

The usual plan of drier is to arrange two rows of bins on either side of the main air duct or wind tunnel. With small driers it is frequent practice to have the bins on one side of the wind tunnel only

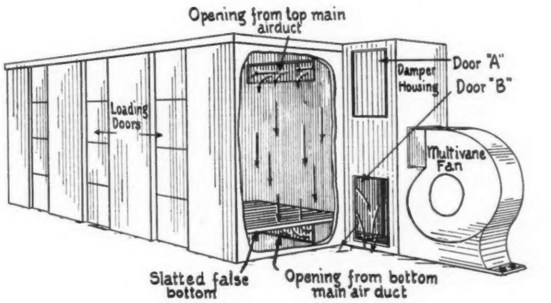

FIG. 2 PERSPECTIVE VIEW OF DRIER

A damper housing is installed between the fan and the wind tunnel proper, by means of which it is possible to arrange to have the air enter the top of the bins and pass out the bottom, or vice versa. In the diagram shown, the air is entering the top of the bins, passing down through the corn, and out the bottom

of complicated control equipment, together with relatively low cost of installation and operation.

General Specifications of the Equipment. A flow of 60 cfm (cubic feet per minute) of air for each sq ft of bin area is specified, at a static pressure of 1 in of water, if the corn is 7 ft deep in the bin; and 1¼ in of static pressure, if the corn is 8 ft deep in the bin, the static pressure measured a few feet from the discharge of the fan. This quantity of air gives a velocity through the corn sufficient to produce strong circulation around all of the ears, and apparently in between the kernels as drying progresses; and a sufficient velocity to remove moisture films from the kernels, so as to produce rapid drying. Any very appreciable reduction in the volume of air will result in considerable reduction in the rate of drying.

We cannot emphasize too strongly the importance of selecting a good blower fan. There has been a tendency for operators to purchase second-hand fans, which in many cases are not the proper type. The multivane type of fan is commonly used, although there are one or two other types of wheels that are successful and economical. It is economy in the long run to buy a good fan in the first place. A medium size of fan meeting the requirements is usually recommended. Avoid fans that are too small.

As the result of several years' experience we suggest that the horsepower requirements of the fan be increased 20 per cent in selecting the power unit. This will take care of belt losses and also the rather hot conditions under which the fan is apt to be operating. It must be borne in mind, of course, that this is an absolutely continuous load, almost dead uniform, and may continue for one to two months, practically without interruption.

Electric power is by far the most satisfactory of all types of power for this work, and usually has been found to be most economical where the operator can obtain high-line service. This power load usually is not large in proportion to the size of the drier. In most cases, it does not exceed 15 hp and, for the majority of driers that are now in use, 3 to 7½ hp meet the requirements. So it becomes a rather desirable load for the power companies, particularly in view of the fact that it is continuous, running day and night. The undesirable feature, of course, is that it is strictly a seasonal load.

The air entering the air duct of the drier should not exceed a temperature of 112 F (degrees Fahrenheit). If the furnace is manually controlled, it is the usual practice to try to hold the temperature between 100 and 105 F, to allow a factor of safety. If the furnace is thermostatically controlled, a temperature of 112 F is recommended, with the thermostat installed at the discharge of the fan. In a large drier, there will be a drop of about 5 F from the intake end of the air duct of the drier down to the far end.

The furnace size can be selected on the basis of allowing approximately 2,000 Btu per hour for each square foot of floor area.

Manufacturers will be able to recommend correct furnace sizes on the basis of the above figure. However, experience indicates that local contractors are not able to make proper allowances for the high velocity of the air through the furnace jacket. Hence they usually recommend furnaces that are far below the necessary requirements.

The furnace housing should be increased in diameter about 15 per cent, unless the furnace is designed specifically for this type of service. Ordinary house furnaces of correct size are satisfactory up to 100 sq ft of bin floor space. For driers with larger floor area of bins, either a battery of house-type furnaces must be used, or preferably a commercial or industrial type of hot-air furnace. These types are usually more efficient than the ordinary house type, and, for large units, the increase in investment is amply justified.

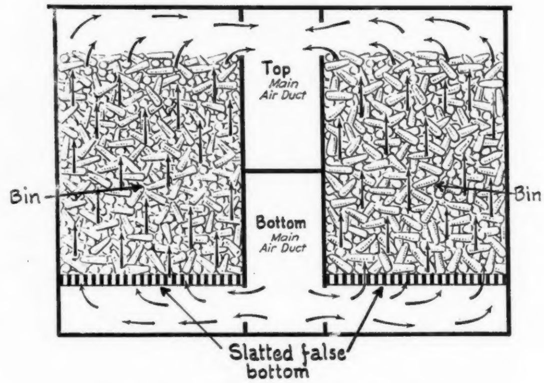

FIG. 3 CROSS SECTION OF BINS AND AIR DUCT

The air duct has a partition extending its length, approximately midway between the top and bottom. In this illustration, the hot air is entering the bottom portion of the wind tunnel, passing through a port into the space underneath the slatted floors of the two bins, up through the corn, out through the top, and back into the top main air duct, from which it is exhausted

Temperature and Humidity Control Equipment. While all of the early driers were manually operated in every respect, there has been a demand in recent years, particularly by the larger users, for thermostatic control of the heating plant. The improved efficiency of these units, particularly when used in conjunction with a stoker, indicates that for larger users this method of control is highly desirable, in view of the fact that accurate control makes it safely possible and desirable to raise the temperature of the air entering the bins to 112 F, which increases the drying rate.

As suggested before, the thermostat should be installed in a short section of duct about a foot long, between the outlet of the fan and the valve damper, and should be set out in the airstream far enough to be free from outside disturbances.

It has been common practice to recirculate at least part of the exhaust air. As soon as the drier has been in operation a few days, the unit as a whole reaches more or less a state of equilibrium, so far as exhaust air is concerned;

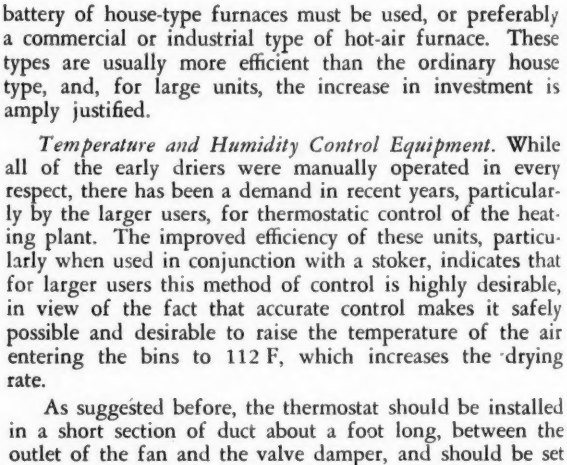

FIG. 4 ANOTHER VIEW OF A BIN

This is another cross section view of a bin showing the doors or ports for admitting hot air and exhausting air to and from the bin

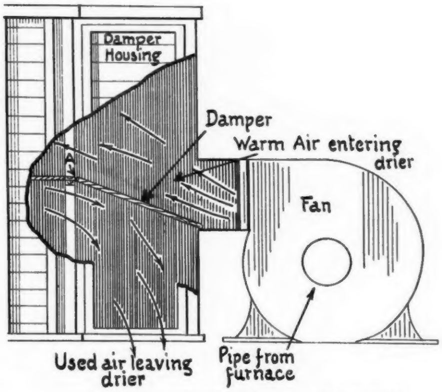

FIG. 5 SUGGESTED DESIGN OF DAMPER

This is used to shift the hot air from the top to the bottom half of the wind tunnel. The usual plan is to shift this valve twice a day; that is, shift it at 12-hr intervals. Thus movement of air through all the bins is reversed at one time

that is, some of the bins are practically dry and others are just starting.

The exhaust air from a freshly filled bin of corn will usually show a temperature of about 65 to 70 F and approximately 100 per cent relative humidity, under Wisconsin conditions. As drying progresses, the temperature of the exhaust air rises and the humidity falls, so that at the last, when the corn has dried down to about 12 or 13 per cent moisture, the temperature drop due to passing through the corn is small, and the exhaust air is of low relative humidity. Now the exhaust air from a number of bins will be some average between these two extremes, with the result that, under average conditions, about two-thirds of the exhaust air can be recirculated. This can vary of course with outside air conditions and with the day-to-day method of handling and filling the bins.

In order to make this control more positive and accurate, plans have been developed for installing an hygrostat in the exhaust airstream returning from the bins, and through suitable, simple dampers and housings provide for exhausting part of the return air, and returning part of it to the furnace, together with a certain amount of fresh air.

In general, it would seem desirable to start recirculation of a small amount of exhaust air when this air is at a temperature of 85 F, and gradually accelerate the ratio up to complete or 100 per cent recirculation at approximately 105 F.

Cost of Drying by the Bin Method. This of course varies tremendously, depending upon the price paid for building material and the price paid for labor, but general experience in Wisconsin indicates that the cost varies from 50 cents to $1.00 per bushel of capacity. This will include the building and the equipment, assuming the building is just for drying, and not one of ample size for storage, shelling, grading, and so forth, or just that part of the building devoted to drying. These figures are based on actual costs of driers built recently in Wisconsin. If the drier is installed in a building already available, the cost will be greatly reduced.

Fuel costs vary widely, depending upon the price paid for fuel, upon how dry the corn is upon entering the drier, the accuracy of the control of the heating plant, and so forth. In general, fuel costs range, under excellent to average conditions, from 2 to 5 cents per bushel, with coal at $6 to $7 per ton.

It is interesting to point out here that with good management, dried cobs will supply all of the heat. A suggested method of use is to shell the corn immediately upon discharge from the drier, run the cobs through a simple type of crusher, and feed them to a modified stoker. Several operators in Wisconsin now use cobs to supply up to 50 per cent of the fuel, thus reducing the fuel cost.

It has been found that the cost for power is usually about the same as the cost for fuel, namely, from 2 to 5 cents per bushel. This will vary with rates, also with the efficiency of operation of the unit, and the moisture of the incoming corn.

It is difficult to definitely state the cost of labor, as it is difficult to determine at just what point labor starts on the drier and where it ends. Of course, only one man is required to operate a drier of any size, in so far as the operation of the drier itself is concerned, whether it be one of 500 or 20,000-bu capacity.

The total operating cost, exclusive of overhead, has been found to vary from 5 to 15 cents per bushel, and, with an original investment of 50 cents to $1.00 per bushel of capacity, it seems fair to charge about 5 to 10 cents per bushel for overhead, which gives a grand total for drying of from 10 to 25 cents per bushel. It is possible that with longer seasons, such as will be found practical in areas south of Wisconsin, and with a thermostatically controlled heating plant in conjunction with the burning of cobs, in a mechanical stoker, it may be possible to lower the total cost below 10 cents. We know of two operators who this past year dried corn at a total cost of 5 cents per bushel exclusive of overhead.

In conclusion, it would seem reasonable to expect a rapid increase of artificial drying for the next few years, following the more widespread production of hybrid seed corn.

Acknowledgment: The author wishes to acknowledge the valuable assistance of Prof. A. H. Wright of the agronomy department, University of Wisconsin, in supplying statistics.

Correction Notice

THE authors of the paper, entitled "Effect of Tractor Tire Size on Drawbar Pull and Travel Reduction," published in AGRICULTURAL ENGINEERING for February 1937 (vol. 18, no. 2), invite attention to minor errors in the two charts at the bottom of page 57. These errors are correctible by changing the legends in the title blocks to conform to the designations used in other charts to show inflation pressures, namely, 8 pounds inflation pressure is indicated by plain circles and 16 pounds inflation pressure is indicated by crossed circles.

Synthetic Materials Superior to Natural Products

THE idea that nature's products are flawless and that they fail in service because of human adulteration is one of the most popular misbeliefs of our time. It is almost the exception to find a natural raw material that is best for the use to which man puts it; as a rule, nature's material is merely the best to be had, or the cheapest. Frequently it contains impurities and lack of uniformity is always troublesome. Improvement in machine design sooner or later collides with the limitations set by the properties of the materials available for machine construction.—Dr. C. M. A. Stine, du Pont Company, before the Second Dearborn Conference of Agriculture, Industry and Science.

What Agricultural Engineers Have Done for Rural Electrification

By E. C. Easter

THERE have been many contributing factors to the accomplishments in rural electrification in this country—the progressive spirit of the American farmer, the aggressive attitude of the electrical industry, and the enterprising energy of the manufacturer of electrical equipment—but in my humble opinion the most important single factor has been the development of increased values of electric service on the farm and in the home. That development has resulted in the farmer's realizing values from electricity to make it possible for him and his family to enjoy its conveniences and comforts on an economical basis. It has resulted in increased revenues from rural electric lines and thereby made the continuous expansion of such lines into more thinly populated areas possible. It has resulted in a larger market for electrical materials and equipment.

The problem of obtaining increased use of electricity by the rural customer was easily recognized as a difficulty, and generally the small usage of electricity by the rural customer was considered as an unsurmountable obstacle to any general extension of electric service into rural areas and to farms.

A vision of the possibility of developing the essential increased values of electric service to the farmers of the country was first created by such outstanding agricultural engineers as E. A. White, J. B. Davidson, Arthur Huntington, M. L. Nichols, and others. These men were able to see beyond the average use of 300 kwh (kilowatt-hours) per year per customer for a few lights; beyond the small average income per farm, from which the electric service bill might be squeezed; to the possibility of electric service as a source of light, heat, and power for many profitable, economical, and satisfactory purposes on the average American farm.

In 1922, Mr. Nichols returned to the Alabama Polytechnic Institute at Auburn from the annual meeting of the American Society of Agricultural Engineers, talking about the extension of electric lines generally to rural communities and to farmers, and about the use of electricity for the preservation of perishable farm products, for controlling insect damage, for heating soil, and for other uses to increase the farm income. With that vision of making electricity serve many useful purposes on the farm and in the home, those leaders planned a procedure of research, investigation, and field studies for the purpose of learning how electricity could be used on the farm, giving full consideration to the fact that rural electrification must be developed on the basis of its value to the farm, rather than as a market for electricity.

They sold their ideas and proposed plan of procedure to leaders of the electrical utility industry, manufacturers, and farm organizations, and in 1923 began to carry out the plan. Throughout the country agricultural engineers became interested in the subject and successfully aroused the interest of the power companies, farm organizations, agricultural equipment manufacturers, and leading farmers in a general effort to learn ways and means of profitably and satisfactorily using electric service on the farm, as an aid to the farmer and his family.

Laboratories in the agricultural experiment stations were equipped for research studies, and electric lines were built in every section of the country for the purpose of practical field studies and investigations.

With amazing rapidity, information was obtained, assembled, published and distributed with reference to hundreds of different applications of electricity on the farm. This work involved an immense amount of hard work in addition to a clear understanding of its purposes, and the ability to obtain the active interest and cooperation of the farmers and others involved in making the studies. In conducting that activity, such agricultural engineers as E. R. Meacham, H. J. Gallagher, T. E. Hienton, G. W. Kable, J. P. Schaenzer, R. R. Parks, H. L. Garver and many others rendered an aid to rural electrification that has been and will always be of growing value to the development.

That work resulted in information that has led to improved equipment, more efficient applications, and more intelligent uses of electric service for many different operations on the farm. It has made available reliable information that has led to tremendously increased values of electric service to farmers and rural communities, and it has made possible the extension of electric service to thousands of farms by virtue of those increased values.

With that and supplemental information, agricultural engineers throughout the country for several years have been conducting educational, promotional, and demonstration work for the purpose of familiarizing farmers with the different uses of electricity, thereby making electric service of growing value to those who have it and a more appealing service to those adjacent to the lines.

Therefore, it seems to me that progress in rural electrification in this country has been developed on the basis of the increased value of electric service to agriculture, and that agricultural engineers have been largely responsible for the activities that have produced those increased values.

Those who have been engaged in the work appreciate that, while the construction of rural lines is essential to rural electrification, the work is not completed, and rural electrification is not accomplished upon the completion of the line; and that without considerable effort subsequent to the completion of the line, the value of the service to the customers is going to be continuously meager. Ten or twelve years ago an average consumption of 400 or 500 kwh per rural customer was usual in most states. When we appreciate that now the average is near 1000 kwh per customer, with many states averaging much higher than that figure, we are aware of the tremendously increased value of the service to the customers now served, and the importance of that increased value upon the possibility of extending the lines to serve others.

The past performance of the agricultural engineers has been constructive and of prime importance to rural electrification. The results obtained should be not only a source of satisfaction to those who have devoted their time and effort to the activity, but also a source of inspiration for even greater accomplishments in the future.

Presented before the Rural Electric Division of the American Society of Agricultural Engineers, at Chicago, Ill., December 3, 1936.

Author: Chief agricultural engineer, Alabama Power Company. Mem. ASAE.

Comparative Efficiencies of Hay Storing Methods

By C. Y. Cannon, E. V. Collins, and D. L. Espe

WITH the development of chopping and grinding machinery came claims by the makers that chopping and grinding of hay were profitable practices because processing hay increased its nutritive values and its consumption by cattle. Many investigators have examined these claims. Two good reviews of the results of such investigations have been made by both the Wisconsin and Ohio agricultural experiment stations[1], [2]. The general conclusions are that chopping or grinding of hay does not increase the digestibility of the nutrients. The main advantage found in chopping or grinding was in lowering the amount of hay refused, by preventing cattle from picking it over anl leaving the coarser parts. In most of the trials it was found to be an unprofitable practice to chop or grind hay after it had been stored in the mow, because the saving in hay did not pay for the cost of such processing.

Occasionally farmers have used their ensilage cutters to chop and blow the hay into the mow directly as it came from the fields. In 1930 the Wisconsin station[3] reported chopping hay direct from the windrow and then blowing it into the mow, but no costs of this operation were given. We have found no data comparing the costs of chopping and blowing hay into the mow directly as it comes from the fields, with unloading it with a hay fork.

In the spring of 1931 an experiment was initiated at the Iowa Agricultural Experiment Station to determine whether hay could be put into storage more efficiently with a hay chopper than with a commonly used grapple hay fork. Certain advantages for chopping hay appeared evident. Data from other sources indicated that at least twice as much chopped hay as long hay could be stored in the same space. Chopped hay could be blown into spaces where it was difficult or impossible to put long hay. It would not be necessary to keep a man in the mow to level the chopped hay while unloading. Chopped hay could be readily removed from storage without the use of a hay knife.

Other important factors had to be tested. These included the relative speed with which hay could be unloaded and the relative economy of the two methods. Comparative observations were also made on the quality of the hay when stored by the two methods.

This experiment called for the same handling and care of the hay, up to the time that it was unloaded from the wagons, regardless of the method used in unloading. An effort was always made to obtain the best hay possible. It was not until the hay arrived from the field that handling differences became effective.

As the loads of hay came from the fields their weights, condition of the hay, the time taken to unload, number of men unloading and other data which might prove of value were taken.

A Papec hay chopper, Model K, was used throughout the trials for cutting the hay and blowing it into the mow. This machine had an 18-in throat and a three-roll revolving drum arrangement for drawing the hay to the knives. With this arrangement no one was required to feed the machine other than to pitch the hay on the endless apron which carried it to the drums.

A six-tined grapple hay fork was used in unloading hay by the fork method. Part of the time one horse was used on the hay fork while a boy drove. The rest of the time the team from the wagon being unloaded was used, and the teamster drove. No effort was made to modify the method of unloading hay with a fork usually practiced on the college farm.

All the hay was elevated onto the wagons in the fields with a hay loader. Each wagon was loaded by first filling the rear half of the rack with hay and then filling the front half. Though two of the teamsters were employed throughout the entire time of the trials, other help varied from season to season and from day to day.

An effort was made to have the hay used in testing each method as nearly alike as possible. It was difficult to make either method efficient without making it continuous over some length of time. For that reason, throughout most of

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[1]Bohstedt, G., B. H. Roche, I. W. Rupel, and J. G. Fuller. Chopping hay for livestock and steaming or predigesting feeds. Wis. Agr. Exp. Sta. Res. Bul. 102, 1930.

[2]Hayden, C. C., C. F. Monroe, and A. E. Perkins. Preparation of feeds for dairy cows. Ohio Agr. Exp. Sta. Bul. 502, 1932.

[3]Wis. Agr. Exp. Station. New hay harvester shows promise. Wis. Agr. Exp. Sta. Bul. 410, p. 131, 1930.

TABLE 1. AMOUNTS AND RATES OF HAY STORED BY USING A GRAPPLE HAY FORK AND BY CHOPPING

	First year		Second year		Third year		Summary of three years	
	Fork	Chopping	Fork	Chopping	Fork	Chopping	Fork	Chopping
Number of loads	23	52	119	59	12	27	154	138
Total weight of hay, lb	41,383	123,404	259,875	122,042	20,443	54,457	321,701	299,903
Average amount hay handled:								
Per minute, lb	104	189	163	132	142	198	151	161.6
Per hour, tons	3.12	5.66	4.92	3.95	4.25	5.94	4.53	4.85
Average cost of putting one ton in storage, cents	39.4	31.8	25.0	45.6	28.9	30.3	27.1	37.1
Variation in rate of storing hay*:								
Fastest rate, tons per hour	6.20	7.24	8.12	4.03	6.13	6.55	4.41	5.70
Slowest rate, tons per hour	2.05	3.57	2.74	2.41	2.93	4.54	2.52	3.57

*Rates were obtained by averaging the five loads that were unloaded the fastest and the five loads that were unloaded the slowest.

the trials, the two methods of storing the hay were alternated day by day, although whenever the hay was not uniform in quality, the two methods were alternated throughout the day.

Table 1 shows the amounts of hay stored by the two methods, the rates at which the hay was handled, some variations in these rates, and the average costs in getting the hay from the wagon into the mow. These are shown for each of the three years of the trial, with a summary of the three years. Table 2 shows the distribution of cost in putting the hay into the mow from the wagon by using a grapple fork and by using a hay chopper.

During the first year of the trial splendid drying weather occurred during the period of hay harvest. This well-dried hay was handled very proficiently by the hay-cutting machine, so that its speed and cost of handling the hay was less than when the hay was mowed with a grapple fork. During the harvesting time of the second year, weather conditions were almost opposite those of the first year. So much rain fell that it was practically impossible to get the hay dry enough to store. As many as five rains fell on some of the hay, which necessitated so much turning in the field that most of the leaves were lost. The cutting of this tough, stemmy, high-moisture-content hay caused much trouble. Overfeeding of the cutting machine occurred frequently, with a resultant clogging at the blower pipes, which reduced the speed of handling the hay, by chopping, to a very low point. On the other hand, the hay because of its high moisture content and consequent matting, handled more rapidly with the grapple fork than the drier hay of other years.

The weather the third year permitted the hay to dry much more than it did the second year. The speed and cost of cutting hay this year was more rapid compared with the grapple fork method than during the second year, but was not as rapid as during the first year.

The summary of the three years' work showed that, from a cost standpoint, storing the hay with a grapple fork was 10 cents per ton cheaper than chopping it. Whether the advantages of chopping hay are worth the 10 cents per ton saved by the fork method over the chopping method, is debatable. Much value may be placed on being able to store two to two and one-half times as much chopped hay in the same space as long hay, when storage space is limited. Though no records were kept, our barn men all felt that it took less labor to get chopped hay from the mow to the cows than did long hay.

The mow in which the chopped hay was stored was 28 ft wide and 36 ft long, and extended to the ground level. The hay was blown into the mow through a window about 25 ft above the mow floor. Our observations on the keeping qualities of the chopped hay showed that, as the moisture content of the hay at the time of storage increased, the amount of "browning" of the hay also increased. The hay on the outer edges of the chopped pile was always greener than the hay in the center and bottom. Roche[4] also found a similar condition. Attempts to prevent "browning," through the use of salt sprinkled into the chopped hay, resulted in failure.

Whenever hay having a high moisture content is stored, whether it is stored long or chopped, it is likely that brown, black, or charred hay will result, because of the temperature generated in the hay. Roche[4] *(Continued on page 157)*

[4]Roche, B. H. Storing chopped alfalfa hay in ventilated containers. Proceedings 28th annual meeting (1935) Amer. Soc. Animal Prod., p. 259, 1936.

TABLE 2. DISTRIBUTION OF COSTS PER HOUR IN PUTTING HAY INTO THE MOW

Using a Grapple Fork	
1 man on wagon at 35 cents per hour	$0.35
1½ men in mow at 35 cents per hour	0.53
1 boy to drive horse on hay fork rope at 15 cents per hour	0.15
1 horse on hay fork rope at 20 cents per hour	0.20
Total cost per hour of operation	$1.23
Using a Hay Chopper	
2 men on load* at 35 cents per hour	$0.70
Tractor at 75 cents per hour	0.75
Hay cutter at 35 cents per hour	0.35
Total cost per hour of operation	$1.80

*One man was a teamster and the other a tractor and machine operator. They alternated in pitching hay from the wagon to the hay-cutting machine.

THIS PICTURE SHOWS AN APPLICATION OF THE HAY CHOPPER FOR CHOPPING AND BARN STORAGE OF HAY. WITH THE PAPEC HAY CHOPPER SHOWN HERE, TWO MEN PITCHING AVERAGED LESS THAN 11 MIN PER TON LOAD FOR 80 LOADS

Processing Engineering in Agriculture

By L. F. Livingston

OUR grandfathers knew that a good milking stool had three legs, each one as strong as the other. The industrial use of agricultural products will not be developed by the chemist alone, the agriculturist alone, or the engineer alone, but by all three, each supporting the movement with equal strength.

Factors which have brought about this grouping together of three separate branches of science have been at work for some time. We have millions of American acres idle because of changing economic conditions, or impoverished by soil erosion or poor cropping practices. We have industry realizing as never before that prosperity depends upon the prosperity of the American farmer, and discovering that further development of the use in industry of agricultural products can do much to enrich American agriculture.

We cannot go back to the days when the farmer who depleted the fertility of his soil could move westward. We do not wish to bring back the system of having heating plants in our stomachs rather than in the basements of our homes. What we are doing is building a new economic structure based on the three-fold foundation of chemistry, agriculture, and engineering.

We are examining the course of modern progress that we may take a competent part in shaping future events. It is clear that we cannot estimate the part that engineers will take in the development of these events without first surveying the prospect as a whole. Processing engineering as applied to agricultural products destined for the factory is a tremendously important part of a complex operation, an operation which involves a multitude of agencies seemingly foreign to each other. We have the industrial scientists working out new uses for American raw materials. We have the agricultural scientists adapting agricultural raw materials to meet industrial requirements. We have the engineer working with both, and with others all along the line, conserving and restoring American soil, perfecting the tools of efficient crop production, preparing the crop for the market, transporting it, processing it, and distributing it. The success of the operation depends upon the coordination of these unrelated forces, an understanding between them of the ends which they seek, the momentums by which they are propelled, and the difficulties by which they are impeded.

Really effective stream control starts with the watersheds, the headwaters, and proceeds downstream. Headwater control through forestry will inevitably result in the further industrial use of American wood products. Many valuable crops having a tendency to retard runoff will be grown where such control is needed. A portion of these crops will find a market in industry. Cheap electric power will facilitate the matter of first processing, the initial step from the farm to the factory. It is plain that these two programs, working together for two separate ends, will be of material aid to each other.

Recent economic disorders have focused attention upon the "agricultural problem", and have brought to prominence the idea that agriculture and industry depend upon each other, more than upon anything else, for a healthy condition of prosperity. Laws have been made, programs have been tried, all with great displays of oratorical and editorial fireworks. But in the meantime, almost unnoticed and entirely unheralded, a natural growth has been taking place. New industries have been born out of the ever-present need for better things for better living for a greater number of people. These industries are based on the chemical conversion of raw materials taken from the soil, raw materials which are perpetually renewable and which add to the national wealth without impoverishing future generations, but raw materials which employ endless labor to produce to the economic maximum, to protect, to cultivate, to harvest, to store and to prepare for the factory.

The first impetus toward a mechanized agriculture came from an acute farm labor shortage. That situation was met by the engineer, and the developments in farm machinery which followed made the American farmer the greatest producer of agricultural goods in the world. The development of commercial fertilizers, insecticides, and fungicides have all presented equipment problems which the engineer has solved. His work along those same lines is far from finished.

Each new product requires individual attention. For example, let us consider the tung tree, a newcomer in America which appears to hold promise of reward for those who have had patience with it. Tung oil is an expensive, widely used industrial raw material, mostly imported at the present time. Tung trees have grown wild in China for generations, but when transplanted to an apparently similar environment in this country, it has been found that much culture is necessary to emphasize the favorable characteristics and make them produce uniformly and abundantly. Stranger than all this, some of the trees have developed nutritional disorders which have resulted in physical abnormalities comparable to rickets and which interfere with profitable production.

It was attempted to add the missing nutritional components to the soil, but with insufficient improvement. So the experiment station concerned with the project worked out an ingenious method of applying them to the outside of the tree trunk, branches, and leaves. The problem was to develop a spray in which the ozmotic pressure was such that the sap of the tree would attract rather than repel the spray. Further, special equipment was made to apply the spray in the proper manner. When this was accomplished, the symptoms of nutritional disorders disappeared, and those trees not too badly affected had a normal growth and production.

This is a perfect example of the results obtained from coordination of many branches of science on the one problem of growing tung trees. As a result of careful research and experimentation, a tung oil industry is slowly taking form in the southeastern United States, which during 1936

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(LEFT) GRINDING IS ONE STAGE OF PROCESSING WHICH CAN OFTEN BE DONE ON THE FARM. (RIGHT) FARMERS ARE READY TO PLANT CROPS TO MEET DEMANDS CREATED BY INDUSTRIAL USES

approximated 2,000,000 pounds of oil valued at about 13.5 cents per pound in tank car lots.

How many problems will crop up in connection with the further development of tung trees to produce nuts of the maximum amount and highest quality oil, I doubt if anyone at the present time knows, or can even guess. We do know, however, that the coordinated efforts of the best agronomic, chemical, pathological, engineering, and industrial brains will be necessary to make this country independent of others in the tung oil industry.

So far engineering activities in agriculture have been largely in the nature of waste-cutting programs. Waste caused by inefficient methods, improper care of equipment, weeds, and insect and other pests, cut the farmer's income by millions of dollars annually, thereby greatly reducing his margin of profit even in good years.

The California Agricultural Experiment Station estimates that weeds alone cost the agriculture of the state between $3,000,000 and $4,000,000 annually. An extension of this program is an absolute essential to the success of any movement favoring the use of agricultural products in industry. It is obvious that industry can buy from the farmer only when prices of farm products are somewhere in line with the prices the manufacturer would have to pay elsewhere.

I have been able to get figures from the records summarizing the extent to which the du Pont Company has made use of raw materials from the soil during the year 1936; and remember that this company is but one of several manufacturing diversified chemical products:

Vegetable oils	35,000,000 lb
Turpentine and rosin	7,124,000 lb
Wood pulp	93,700,000 lb
Cotton linters	51,293,000 lb
Corn products	20,156,000 lb
Molasses	40,020,000 gal
Cotton fabrics	12,500,000 lb

To this list, impressive as it is, should be added a number of less important raw materials, the sum of which makes a considerable volume.

You will be particularly interested in the fact that, already, more than 62 per cent of this volume comes from American acres. A few years ago this percentage was much smaller. We all look forward to the time when a larger percentage can be obtained in this country.

The factors which control the kind, location, and extent of the development of processing equipment and methods include (1) the form and quantity in which the manufacturer desires the raw product; (2) the intended use and economic value of the by-products; (3) the cost of storage and transportation from the farm to the factory; and (4) the availability of proper and adequate power facilities. These four things must be considered separately and together to determine the best economic use of any of the farm products destined for factory conversion, and to work out the most efficient methods for handling them. Each of these four factors may be subdivided many times in order to determine the key to successful use.

In connection with the development of the Jerusalem artichoke, a harvester is apparently one key. Harry Miller summarizes this harvester problem as follows:

1 The stalks, which are tall and rather bulky, must be conveyed aside before digging operations can be carried on.

2 The tubers are not very compact in the hill on most existing varieties, and the digger must be designed to accommodate this condition.

3 The tubers must not be bruised, because they decompose readily when such injury occurs.

4 The plant has a massive root crown, to which the tubers are fastened with a strong feeder cord. The root crown must be separated from the tubers and eliminated in a manner that does not result in bruising the tubers.

5 The tubers must be reasonably free from earth and from other foreign matter before delivery to the industrial plant.

From these five conditions it can be readily understood that there is a very definite engineering problem to be solved.

In a great many of the processes by which raw farm materials are prepared for the factory, there occur waste products or by-products which have a varying usefulness and value. There are a thousand and one illustrations of this point. I have chosen in this case the soybean, because it is widely distributed over the country and because it now has so many different uses.

In 1936 it was grown in twenty-five states on 5,635,000 acres, producing almost 30,000,000 bushels of beans, and assisting materially in retarding the inroads of soil erosion through its soil-building characteristics and by the nature of its root formation.

The oil extracted from the soybean goes to various factories, where it is a valuable constituent of such products as paints, lacquers, varnishes, glues, coated fabrics, and

many others. The residue is a meal of high nutritive value, but also capable of conversion into a variety of plastics almost revolutionary in their adaptability to industrial uses. Sometimes the meal is kept right on the farm to be mixed there with other stock foods, but usually even the food uses involve a factory process.

Storage problems in connection with most crops are of vital importance in the processing program. For example, tobacco, now a $250,000,000 crop, has been grown in widely spread areas of the United States for generations. It is a crop which has been bred and selected until there are numerous diverse types suited to different specific purposes, and to the climatic conditions of the nineteen different states in which it is grown. It is produced not only for the pleasure and relaxation of the human race, but it has many uses in industry, such as in the manufacture of insecticides and fungicides, with further possibilities still to be explored. Tobacco is subject to easy and quick deterioration, and the wastes along the way to the consumer have been shocking. These wastes have occurred most alarmingly in the process of curing and storing.

A research program, instituted at Lexington, Kentucky, involving engineering, plant pathology, agronomy, and physics has been exploring the course of the product from the soil to the market, finding where and why these wastes occur, and determining methods by means of which they can be minimized or even completely done away with. Detailed studies were made of the environmental features necessary to bring out required characteristics. The result has been a revolutionary advance in the design and construction of curing and storing structures. Entirely new building principles, entirely new materials, entirely new treatments have developed absolute physical control during the curing stages, making more profit for the grower, less cost for the consumer.

Similar improvements in processing of other old crops such as corn, wheat, oats, cotton, and potatoes will doubtless come about, and equipment for processing the new farm crops is likely to change the rural landscape of America. One wonders if future generations will have anything at all resembling the old red barn that is so familiar to us.

A summary of the situation seems to bring out a few points that are, even now, apparent to the observant.

Conservation is a very important part of the general program. I mean conservation of the national wealth. It is a dream, perhaps, but a challenging one, that future generations shall inherit a land in which every acre is at work, adding to the national wealth. As among humans, some units will produce but little. Some acreages will offer only a meagre growth of scrub pine, but even the scrub pine does its bit in assisting with water retention, providing cover for wild life, and eventually providing wood pulp for the benefit of all. The work of Dr. Herty, and the millions of dollars being invested in pulp and paper plants in the South for the utilization of slash pine wood, is ample evidence of this. Other acres better equipped by nature will add, no one yet knows what, to the comfort and convenience of our living.

If agriculture is further to grasp the opportunity offered by the industrial market, every effort must be made to make the production cost as low as possible consistent with maintaining a reasonable margin of profit for the producer. This problem is being solved by new methods, new machines, new storage facilities. The work must continue.

The industrialist must not relax his research efforts to find new uses for raw materials which can be supplied yearly with little or no loss to our permanent resource wealth.

A successful consummation of this program will require the utmost cooperation between all branches of science. Efficient procedure demands a definition of industrial needs by industrial scientists, followed by analysis and solution of the problems by agricultural and engineering scientists.

The factors that are at work creating a new relation between agriculture and industry have brought forth, along with new benefits, a whole series of new clues to follow that are essentially engineering in character, and which will demand an engineering solution.

Comparative Efficiencies of Hay Storing Methods

(Continued from page 154)

has shown that, with chopped hay, the height to which the temperature rises increases with (1) increased moisture in the hay at the time of storing, (2) increased width of the hay container from one ventilated wall to the other, and (3) the increase in density of the mass as determined by such factors as length of cut and coarseness of the hay. To curtail the dangers arising from overheating, hay should contain not more than 23 per cent moisture when chopped, it should be stored in narrow, well-ventilated containers, and should be chopped coarsely to make the mass of hay less dense.

Feeding trials showed that the chopped hay was eaten as readily by dairy cows as similar hay put up by the fork method, except when the hay was charred to a blackened condition. This blackened condition occurred with a portion of the chopped hay only during the second year. Milk cows yielded as well when fed the chopped hay, whether it was green or brown, as when they were fed uncut hay.

Cut brown hay was tested against green hay with young rabbits, for palatability. They evidently relished brown as much as green hay, for they thrived as well and grew as fast on either.

SUMMARY

Hay cured in the field can be successfully chopped and blown into the hay mow by a hay chopper.

Hay was stored in the mow at a faster rate with a hay chopper than with a grapple fork. However, the cost per hour of operating the hay chopper was greater than the cost of the additional man and horse labor when the hay was stored with a grapple fork.

The cost per ton of chopping and blowing hay into the mow was slightly more than when it was mowed away with a grapple fork. Hay with a high moisture content was relatively more costly to chop than hay with a low moisture content.

Chopped hay cured somewhat browner than similar uncut hay. Unless chopped hay is very dry it cannot be expected to cure in the mow without browning.

Palatability of hay was evidently not injured by the chopping process, though blackening of hay, whether chopped or unchopped, did injure its palatability.

Engineering's Professional Progress

By Quincy C. Ayres

I SHOULD like to sound a note of optimism, not the Pollyanna kind, but optimism founded on cold facts. It has been a long hard pull out of the greatest depression of all time, but engineering unemployment has now dwindled to practically nothing and there are many other signs of returning prosperity. Almost all large corporations and employing companies have resumed their training courses for young graduates after a lapse of several years. A recent survey at Iowa State College among the 1,252 engineering graduates during the past 6 years showed that 1,114, or 89 per cent, are now engaged in engineering work of their choice, and only 2 per cent are unemployed or unaccounted for. This is believed to be typical of conditions prevailing in the state and over the country as a whole.

In the years to come it is my firm conviction that engineers will share ever more generously in the wealth they so largely help to create. These are perilous times for entrenched interests and established traditions that are unable to justify, not only their existence, but also their emoluments and rewards on a basis of services rendered. The public is slowly becoming aware that engineers are primarily both clear *thinkers* and resolute *doers,* seldom satisfied until tested theories are translated into action. With the application of engineering techniques to ever widening fields of activity, just and proper recognition based on result-getting ability is eventually bound to follow. As much as engineering talent and enterprise now make possible practically every phase of modern living, we are only at the threshold of the real call to service that will come when economists and others responsible for distribution catch up with the procession. In the face of great need for goods and services of all kinds producing power cannot indefinitely be held in check.

Within very recent years the pseudo-religion of technocracy was sweeping the country, bowling over engineering ideals and screaming maledictions that society had been betrayed. Even engineers were persuaded into believing that overproduction rather than underconsumption was the primary cause of the depression. Like every other fury not wholly founded on truth, however, technocracy soon spent its force and is now as dead as the dodo. It died from natural causes as one look at the facts will disclose.

During the half-century from 1879 to 1929, eighteen major industries have arisen in the United States that provide direct employment for more than a million workers and indirect employment for untold millions more. The automobile, motor truck, and tractor industry alone is credited with having created 11,000,000 new jobs, if raw material industries and allied occupations such as transportation, garages, and filling stations are taken into consideration. Some of the other more obvious industries founded during this period are rubber, gasoline and oil, asbestos, aluminum, fountain pens, typewriters, phonographs, motion pictures, radios, and aircraft. Taken all together, these new industries have elevated the standard of living of whole nations of people and have vastly increased the sum total of human happiness and welfare.

Yes, engineering activities have a way of creating new industries, new wealth, and, given enough time, new employment. Technological unemployment is a temporary problem of readjustment, and as such is entitled to our best thought and action. It is very clearly a growing pain of progress.

I approach with considerable trepidation the many-sided problem of professional recognition, and its companion problem of compensation commensurate with the magnitude and value of the services rendered. These questions have baffled better brains than mine for years and probably by their very nature are analytically insoluble. Yet we owe it to ourselves to continually review these matters and bring to bear the best thought that grows out of cumulative experience. Reams of material have been written on the subject, which in its general aspects involves the whole philosophy of human relations. It is appropriate, therefore, that I confine my remarks to the contributions toward this end that can properly be advanced by engineering organizations.

It may be true, as is so often charged, that engineers habitually underrate the value of their services, but use of strong-arm tactics is certainly not the way to go about correcting the situation. Militancy of the wrong kind, and applied in excessive doses, has always defeated its own purpose in the end, and always will. One of the foremost obligations of our society, as I see it, is to clear away artificial barriers to individual success and keep open the avenues of progress to all with sufficient initiative and ambition to undertake the journey.

Another function of prime importance is to safeguard the public interest and restrict unfair competition by admitting to practice only those persons who prove themselves properly qualified. Great strides in this direction are being made at the present time both by tightening and unifying registration laws and by extending them gradually to all states and to include all classes of engineers.

The growth of professional consciousness among engineers in general has been more rapid in recent years than for many years past. This is being manifested in many ways, principally by recognition among ourselves of closer community interests, by constant attention to improved standards in education, and by better coordination of effort through American Engineering Council and the Engineers' Council for Professional Development.

As the work of the engineer spreads out into virgin territory more and more contacts will be established which in turn will foster better understanding and appreciation, if our work is well done and we do not appear too often in "field uniform." One of the most effective pieces of publicity imaginable is afforded by our modern highways that touch the lives of practically every citizen and are recognized admiringly as the work of engineers. But even this contact is silent and impersonal.

There are of course many other problems and difficulties to be faced from time to time. They all fall in the category of "growing pains" and I have every confidence in our ability to deal with them satisfactorily as they arise.

Excerpts from the president's address before the 49th annual meeting of the Iowa Engineering Society.

Author: Patent manager, and associate professor of agricultural engineering, Iowa State College. Mem. ASAE.

Use of Fill Insulation in the Construction of Refrigerated Rooms

By Willis M. Rees

APPLICATION of all the commonly used forms of insulation in ordinary building construction is well known. It is, therefore, the use of hand-installed fill types of materials in the construction of refrigerated rooms which will be described in this paper.

The rigid block types of insulation, such as cork, have been most commonly used in the construction of such rooms. As there has always been the problem of moisture condensing and forming water within the insulation materials, they have been applied with hot asphalt in an attempt to hermetically seal them so that no vapor could get into the materials, which would form water when it was chilled. The inside surface was also sealed and covered with portland cement plaster.

As no practical method of hermetically sealing the insulation has ever been found, the construction frequently became watersoaked, causing lowered efficiency of the insulation, and eventual deterioration.

During the past few years well-known psychrometric principles have been applied to cold storage construction, using relatively porous types of fill insulations. Greatly lowered costs and permanent efficiency of the insulation are the result.

On October 17, 1929, the U. S. Bureau of Standards published circular No. 376, entitled "Thermal Insulation of Buildings". It gives a general discussion of the subject of insulation for building purposes and ends with a brief discussion of refrigerator or cold storage insulation. The following is quoted from that particular section of the discussion:

Presented before the Farm Structures Division of the American Society of Agricultural Engineers at Chicago, Ill., December 1, 1936.

Author: Insulation engineer, U. S. Gypsum Company.

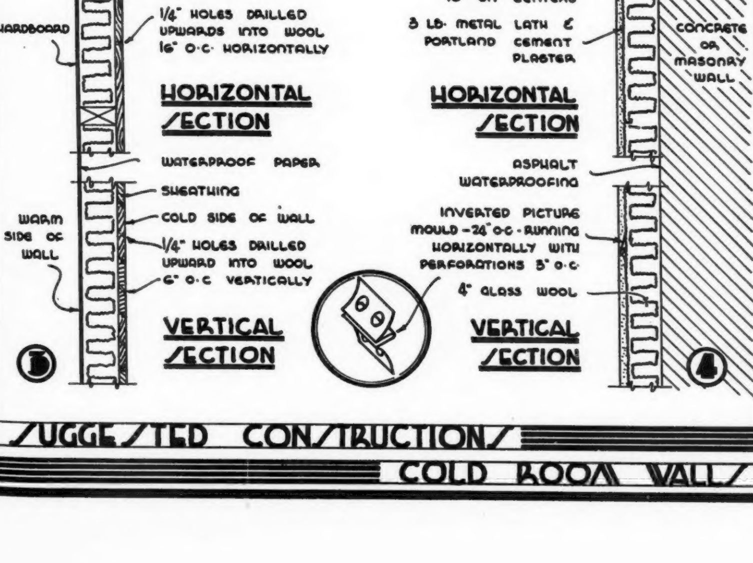
The question of the so-called moisture-resisting qualities of insulating materials merits some mention at this point, since it is an important one in refrigerator or cold storage insulation. Ordinarily it is of minor importance in house insulation. No tests have been made at the Bureau to compare materials on the basis of their moisture-resisting qualities, since tests of this kind should be made on completed construction rather than simply on the materials themselves.

To the best of our knowledge, no commercial insulating material is in any sense waterproof or moistureproof. If immersed in water or kept in air at 100 per cent humidity, one material may absorb water less rapidly than others, but this fact is of minor importance. All the materials in question are permeable to water vapor, and if the insulation is colder than the outside air, and is not protected on the outside, most of the water vapor which diffuses into the insulation from the outside will condense and accumulate, eventually producing a more or less saturated state and lowering the insulating value many times. In a completely saturated state there is undoubtedly very little difference between the respective thermal conductivity in the various commercial materials. The only remedy for this state of affairs is adequate protection on the outside by means of airtight coatings, and, when possible, vents from the insulation to the inside should be provided. The latter allows the insulation to dry out, since the inside air is colder. As a general rule applying to insulation structures, airproof the warm side and ventilate the cold side to the colder air. In no case should the insulating materials themselves be relied upon to prevent water accumulation.

No discussion is made in the circular to give the full explanation of the reasons why venting the inside serves to keep the insulation in a permanently dry condition. As the idea of ventilating the cold side of the construction is so diametrically opposed to the ideas which have been used for so many years in cold storage construction utilizing block type insulation, it is advisable that a thorough discussion of this principle and how it functions be given.

The dehydrating action through the vents provided in the inner wall of the cold room can be technically explained as follows: Air is a mixture of gases consisting primarily of oxygen, nitrogen, and water vapor. There is no such thing in nature as dry air, that is, air containing no water vapor. Air pressure at any particular point or locality is the total of the pressures of the respective gases whose mixtures form the air itself. If it were possible to completely remove all of the various gases from a sealed container filled with air, with the exception of the water vapor, there would still remain the pressure of the water vapor itself. The vapor pressure depends upon the amount of vapor present for a given volume.

It is a known fact that the warmer the air, the more vapor it is capable of holding. When the temperature of air containing vapor is reduced to such an extent that it can no longer hold all of the vapor, the excess amount condenses and forms water. This is what is liable to happen in the so-called sealed constructions of cold rooms. Vapor



SUGGESTED CONSTRUCTIONS COLD ROOM WALLS

leaks in through the outer seal, is chilled in the cold part of the wall and condenses, and the water accumulates. When air contains all of the water vapor it is capable of holding at a specific temperature, it is said to be saturated or have a relative humidity of 100 per cent. For example, in air having a temperature of 70 F (degrees Fahrenheit) and a relative humidity of 100 per cent (saturated air), there will be present 8.07 grains of moisture per cubic foot. If the relative humidity is cut to 50 per cent, there will be 4.03 grains of moisture per cubic foot. The vapor pressure for the air at 70 F, with 100 per cent relative humidity, will be 0.7386 in of mercury. If the relative humidity is cut to 50 per cent, the vapor pressure will be one-half of that, or 0.3693 in of mercury. This means that if a closed container of air having a 70 F temperature and 100 per cent humidity is within an inclosure of air of 70 F having 50 per cent humidity, there is a difference of pressure between the inside and the outside of the container of 0.3694 in of mercury. If a small vent is provided from the container of air having 100 per cent humidity into the room having 50 per cent humidity, there will be a movement of vapor due to the difference in pressure, from the higher vapor pressure area to the lower vapor pressure area, until an equilibrium has been reached. In other words, there is a positive vapor pressure which causes the vapor to move from the higher pressure area to the lower pressure area.

Now, if we consider our cold room having an inside temperature of 0 F, with the temperature outside of the cold room being 70 F, we can show that there is a positive pressure forcing the vapor from the warm area to the cold area. Let us imagine our cold storage construction with the warm side of the insulation sealed as tightly as possible so that there is a minimum of leakage through it into the insulation, but the inside or cold side of the insulation being freely vented to the cold air. If the warm air of 70 F has a relative humidity of 50 per cent, there is a vapor pressure of 0.37 in of mercury. If the cold air having a temperature of 0 F has a relative humidity of 60 per cent, it will have a vapor pressure of 0.023 in mercury. There will therefore be a difference in vapor pressure between the warm and the cold side of 0.347 in of mercury. It can therefore, readily be seen that if there is any possibility of vapor getting through the wall construction, there is a positive pressure actually forcing it through. If the warm side of the construction is sealed as tightly as possible, but with a very slight leak, the providing of free ventilation through the cold side permits any vapor coming through the sealed side to very readily pass into the cold room. Therefore, by sealing the warm side and freely ventilating the cold side, any dampness which gets into the insulation is literally sucked out of it so that there can never be sufficient moisture in it to condense.

In the case of a cold room having a temperature of 0 F, the temperature on the surface of the cooling coils or refrigerating area probably will be about —10 F. As moisture condenses and freezes on these cooling surfaces, the vapor pressure in the cold room will not be higher than the vapor pressure of saturation for —10 F, the temperature on the surface of the cooling coils, unless vapor is being fed into the room faster than it can be condensed on the cooling coils. Under no circumstances can the relative humidity in the cold room be higher than 100 per cent, which for a temperature of zero means a vapor pressure of about 0.038 in of mercury. In the example cited above there will still be a pressure difference between the inside and outside of the cold room of about 0.332 in of mercury. We therefore still have the dehydration process working efficiently.

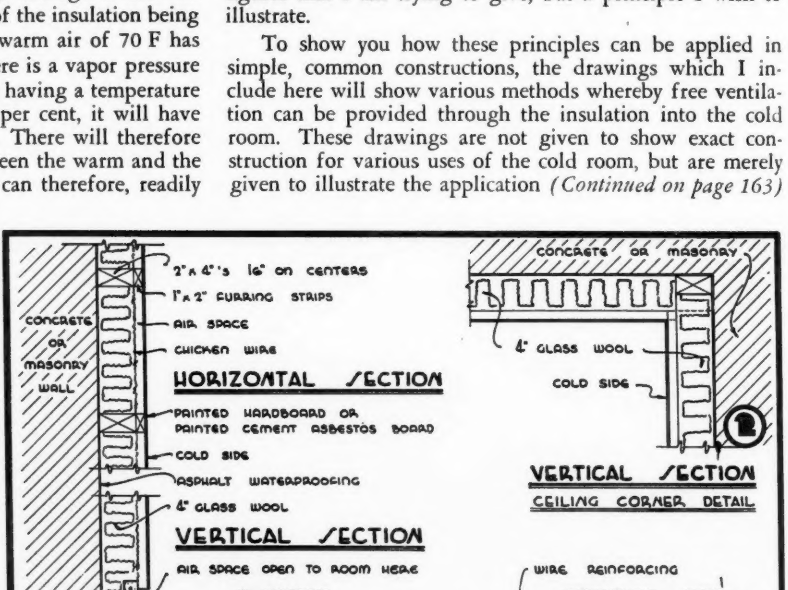
With free ventilation provided between the insulation in the cold storage construction and the cold air, the amount of vapor present in the insulation can never be more than within the room, with the result that there is never sufficient vapor present to cause condensation.

All of the above discussion has been given for a specific set of conditions, but the same principle applies regardless of what temperatures are considered so long as the temperature within the cold room itself is lower than the temperature outside of the cold room.

The period during a year when the outside of the cold room is colder than the inside is normally so short that the possibility of frost forming in the insulation next to the sealed side will be extremely slight. When the usual conditions reoccur, the dehydration process would again dry the insulation and keep it dry.

All of the vapor pressures given in this discussion have been taken from various tables, with the result that it may not be possible to accurately check these figures against any table you may be comparing them with, although you will find them substantially correct. However, it is not specific figures that I am trying to give, but a principle I wish to illustrate.

To show you how these principles can be applied in simple, common constructions, the drawings which I include here will show various methods whereby free ventilation can be provided through the insulation into the cold room. These drawings are not given to show exact construction for various uses of the cold room, but are merely given to illustrate the application *(Continued on page 163)*



Better Milk with Electricity

By H. S. Bingham

BUFFALO CREEK FARM does in some measure represent a typical example of what may be found in the way of electrification on many farms where dairying is the major interest, and possibly what one might reasonably expect to be the development in that line on many other farms if electric service were made available at a reasonable rate. I say this because even though we are at present what may be considered a relatively heavy rural user of electricity, we did not get that way over night. And I believe that on most other farms a gradual extension of the use of electricity is to be expected, rather than a sudden transformation.

There are, in my opinion, two reasons for this. One is that the farmer must learn, through education and actual experience, the satisfaction and economy of electricity's use; and the other is the fact that the farm must pay the bill for the transformation. Few farms during the past few years have been or are at present able to stand the expense of complete electrification at one time. On Buffalo Creek Farm we are inclined to regard electric service as one of our hired hands, and it so happens that our monthly bill closely approximates what we pay one of our best men. If we should be required to dispense with the services of either of these, there is no question in my mind as to which would have to go. We could perhaps replace the man overnight, but if we had to look for something to take the place of electric service, we would not even know where to start looking for it.

When my brother and I took over the operation of Buffalo Creek Farm in 1924, we had electric service provided by a home-electric plant. We made little or no attempt to make use of this power other than for light, as the requirements of two homes and the numerous farm buildings kept the little plant well loaded, particularly during the winter months. The only motors in use on the farm during that time were two which operated washing machines and one on a vacuum sweeper. In the winter of 1928 we were able to put the home-electric plant into permanent retirement, for the time had come when we were able to turn on the power from the high line. At the present time there are 25 motors on Buffalo Creek Farm, most of which are in daily use. Thus it can be seen that, while at first practically the only demand on the new service was for light, a gradual increase in the demand for power has brought this demand to a point where it is several times greater than that for light, even though the demand for light has increased to some extent.

Since our major interest is in our dairy, it is but natural that we find in connection with this our greatest use of electric service. One of our more recent adaptations in the dairy has been the installation of electric equipment for the pasteurization of milk. This was, at the time of installation, and as far as I know still is, the only equipment of its kind in Illinois. Due credit for this installation should be given to Richard Boonstra of the Public Service Company of Northern Illinois. He was responsible for the exhibition of a model of this equipment at the 1933 Century of Progress, and it was this exhibit that aroused our interest. We had at that time been considering the installation of steam pasteurizing equipment, but after getting information concerning this newer process, the question resolved itself into which type seemed best adapted to our needs.

There were many angles to be considered. In the first place, the electric process was not recognized as a method of pasteurization in the state of Illinois. Correspondence with the state department of health tended to discourage our favoring this process, since we would not be permitted to place the word "pasteurized" on the label of our milk. They also expressed the opinion that we would find the

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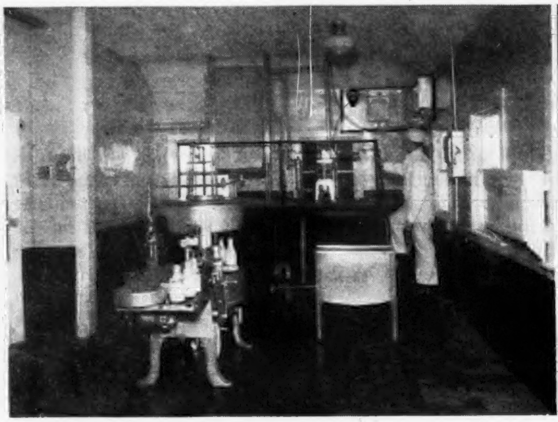
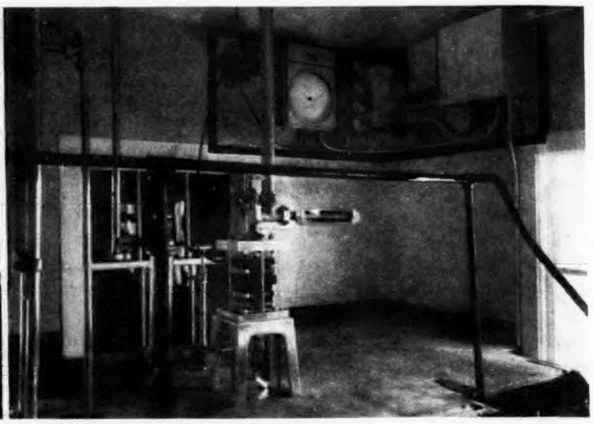
Presented before the Rural Electric Division of the American Society of Agricultural Engineers at Chicago, Ill., December 3, 1936.

Author: Manager, Buffalo Creek Farm.

BUFFALO CREEK FARM, A DAIRY ENTERPRISE UNDERGOING PROGRESSIVE ELECTRIFICATION

TWO VIEWS OF THE ELECTRICALLY OPERATED PASTEURIZING AND BOTTLING EQUIPMENT OF BUFFALO CREEK FARM

cost of operation excessive. Then came the question of the comparative safety of the two processes. Since we were distributing only milk from our own herd, and which was produced under rather carefully controlled conditions, we were not interested in pasteurization primarily as a method of reducing bacteria counts or improving the keeping quality of our milk. Our product was already superior in those respects to most pasteurized milks. We wanted, however, to be able to give assurance to our trade that our product would be, as nearly as possible, 100 per cent safe from the danger of pathogenic infections.

After a rather careful investigation of the results of many tests conducted with the electric process on the more common types of pathogenic organisms, and of comparative tests made with both types of pasteurization, we concluded that there was but little difference as to safety in the case of most types of organisms, but there was a marked difference in the case of certain types, in favor of the electric process, as I shall point out later. Furthermore, the process was recognized by the U. S. Public Health Service as a suitable method of pasteurization, which alone should be a guarantee of its safety.

Then we had to consider what we might expect in the way of reaction on the part of our customers, with respect to both types. Here again the advantage seemed to be in favor of the electric process because, since we had been distributing an untreated milk for a number of years, we knew that many of our customers strongly favored that kind of milk, provided that it came from a reliable source. Were we to suddenly start serving them with milk labelled "pasteurized," we were sure that the protests would be loud and numerous. However, if we were to use the electric process, we knew we could honestly assure them that the milk was exactly the same in every way as it had always been, with the exception of an added factor of safety.

There was also the question as to the extent of appeal our product would have to prospective customers who favored pasteurized milk. It seemed reasonable to believe that we should be able to sell these people on the idea of a method of treatment superior to ordinary pasteurization. We had also hoped that with a pasteurized product, we would be able to extend our delivery to a certain suburb where pasteurization was required and where restrictions were rather rigid, so there was the question as to the attitude the board of health in this place might take.

At any rate, after due consideration of these factors and many others, the electric equipment was finally installed, just about two years ago. It has been in successful operation ever since. We experienced no unfavorable customer reaction and were able to add a number of new accounts to our list. Shortly after this we made application for license to deliver in the suburb mentioned. After inspection of our plant and equipment and after plate counts were made of our product, permission was granted without delay. Last year the state pasteurization law was amended so that this process was recognized, and we were subsequently ordered to place the word "pasteurized" on the label of our milk. It has come to me indirectly that officials of the state department of health have even gone so far as to recommend this type of equipment in plants where replacement is necessary.

One of the outstanding advantages of this type of pasteurization is that the milk seems to retain all of its natural and original properties. Even vitamin C, which is the most fragile of the vitamin group, is not destroyed, while it is completely removed in the ordinary process. This particular vitamin is subject to destruction by oxidation, which is hastened by the presence of air and contact with certain metals, of which copper and copper-bearing metals seem to be the worst offenders. There is, in vat pasteurizers in particular, the ideal setup for this oxidation to take place. For this reason, physicians generally do not recognize milk as a source of vitamin C.

Another important advantage, in my opinion, is that it is more easily possible to obtain a product which is uniformly low in bacteria count. There are several contributing factors which may have important bearing on this point. One of these is the fact that this process is more effective in the destruction of certain types of organisms which are known as bacterial endospores or spore-forming organisms. In comparative tests conducted at Michigan State College with respect to the efficiency of both types of pasteurizers in destroying members of this group, it was found that in the holding process destruction was only from 0 to 13 per cent, while in the case of the electric process, it was from 71.5 to 99.9 per cent. Health authorities with whom I have come in contact have regarded this as a very important factor in favor of the electric process.

Another group of organisms that must come in for consideration here is the thermophilic group. These bacteria find the relatively high temperature of slow pasteurization more or less favorable to growth. In a common type of vat pasteurizer the heating, holding, and cooling periods may together require nearly an hour's time, especially for

the last of the milk to be cooled. This gives ample opportunity for the growth of thermophyles, if such happen to be present. It is even possible for milk after pasteurization to have a higher count than before treatment on this account. The short heating and holding period and the higher maximum temperature of the electric process prevent any difficulty from this source. Another factor which is important is that there is a considerable smaller area of milk-contacting surface to be cleaned, and since no heat is applied to the milk through these surfaces, they are more easily cleaned. Hence, there is less chance for contamination from this source.

No doubt all of these factors have played a part in making possible the consistently and uniformly low plate counts which we have been able to maintain in our milk since we have been using this process. It has been brought to my attention that many smaller dairies have some difficulty in maintaining either a low or uniform plate count, and for this reason many doctors recommend the product of the larger dairy. Their count may not be the lowest but, generally speaking, it is more uniform. Our average count during the past two years is a little less than 1500, with only two counts above 3000, and with many below 1000. Since the lowest maximum allowed in any town where we deliver is 30,000, we should have no difficulty in keeping well below requirements. It has been our experience that nothing will do more toward creating a favorable attitude on the part of doctors and health officers toward milk, than to have it show a consistently low count. I am inclined to give the electric process credit for the record shown by the counts just mentioned and for the reputation which our product enjoys of having the lowest count of any milk offered in north shore suburbs.

In the town where we started delivery soon after this equipment was installed, we have added to our list of customers five prominent physicians who are using the milk for their families. Two of these are well-known pediatricians, and one had been patronizing one of the larger dairies for more than 15 years. We were also asked to present a bid for the business of serving one of the largest schools in this town, a privilege which had never before been extended to a small dairy.

As to the cost of operation of this unit, I have figures based on a day's run which should be representative. On December 1 we processed 183 gal, or 732 qt of milk. Total time, including time for heating salt solution was 135 min. Based on its rated consumption, the machine used 22.5 kwh. At our rate this means a daily cost of 45 cents, or 2.45 mills per gallon, or approximately one-sixteenth of a cent per quart. This may be slightly higher than the actual cost of steam, if steam were used, but I believe the convenience, simplicity, and reduced area of cleaning surface would be more than ample compensation for the difference.

I feel that with the record we have made and the favorable attention we have been able to attract, progress should continue from the sales standpoint in the same steady manner that has obtained so far and with less effort on our part.

Use of Fill Insulation in the Construction of Refrigerated Rooms

(Continued from page 160)

of a principle and show various ways in which the ventilation may be provided. There are undoubtedly many other ways that this principle can be applied, and there are, of course, many special requirements for individual rooms which may make variations of these methods necessary.

Although these ideas of cold storage construction may be new, they are not untried. There are many jobs utilizing this principle which have been in service for several years and no signs of moisture accumulation within the insulation has been evidenced. The jobs with which I am most familiar have used glass wool for insulation in varying thicknesses from 4 to 8 in. The glass wool has an insulating value slightly superior to the block forms of insulation, 4 in of the glass wool being the approximate insulating equivalent of $4\frac{1}{2}$ in of the block insulation. The greatest number of these jobs are in the southeastern portion of the country, where rather warm, humid outdoor conditions are common, and would therefore represent a rather severe test of the system.

Domestic refrigerator manufacturers, when they first began constructing their cabinets, attempted to completely seal the insulation by wrapping it in sealed packages and by sealing the cabinet itself as tightly as possible. Even with this construction it was found that it was so difficult to control the manufacture that over a period of years there frequently was an accumulation of moisture within the insulation with an ultimate reduction of the efficiency of the refrigerator. As a result, some of the larger refrigerator manufacturers today are utilizing the principles I have described in building their refrigerator cabinets. They use the glass wool in blanket form without any attempt of wrapping it into sealed units, and they then provide small vents through the inside of the cabinet into the cold area. They have found that by so doing there is no accumulation of moisture in the insulation, and the result is a refrigerator which does not lose its efficiency in time due to a reduction in the value of the insulation.

The type of insulation which is most suitable for these cold storage constructions is one which in itself will not absorb dampness nor retain it, and one which is loose and fluffy, permitting a ready passage of vapor through the material. It should be a material which will remain permanently in place, and is in form which may easily be handled. It should not be attractive to vermin or rodents, and should have great chemical and physical stability. It should also be a fireproof material which is not affected by water or ice. It must not absorb nor give off odors.

It is not the intention of this discussion to indicate that fill types of insulation can be universally substituted for the block types of insulation. It is obvious that in the construction of a milk cooler where the cans of milk are placed in cold water that the block type of insulation is still probably the most suitable type to use. There will obviously be other similar constructions which should use the block type rather than the fill type. However, the usual type of cold room can be constructed with fill insulation, using the ventilated construction, for a fraction of the cost of block type insulation which has been commonly used in the past.

The Place of Steel in Farm Building Construction

By Earl D. Anderson

MANY of the industries supplying the building materials commonly used on the farm have been actively engaged in both research and educational programs over a period of years, to help farmers use their products to best advantage.

The steel industry, however, apparently has considered the farm building market largely as a matter of course, and until recently has not been prominent in product development in this field. For many years the line of steel building products available for the farmer's use has been limited largely to metal sheets and hardware items. However, with an awakened interest in the farm problems, the steel industry is well equipped with its engineering and metallurgical staffs, experienced in adapting steel to new uses in industry, to help farmers use its products to better advantage than heretofore in farm building construction.

The steel industry is no longer just a producer of plain steel. Whereas at one time the main products of the steel mill were rails and a few other heavy products, the industry today makes hundreds of products in as many as 100,000 sizes, shapes, and chemical analyses. With the ramification of industry, the uses of steel have multiplied many times.

Together with advancement made by the steel industry, agriculture has risen in importance as a consumer of steel. In the period 1922 to 1933, the farm was the seventh largest market for steel. In 1934, it rose to sixth place, and last year reached fourth place. In 1935 a total of 2,270,000 gross tons of steel went to the farm market. This comprised about 10 per cent of the total output of finished steel.

With each new purchase of an automobile, a tractor or a farm implement, the farmer is conscious of improvements over the older types, the result of research by the designer and the steel industry. New alloy steels, tailor made for each specific job, have contributed toward making possible these better machines and implements. Greater use of steel in these many forms on the farm has helped to give the farmer confidence in steel, and also helped to overcome any possible prejudices which he may have held.

Steel has many inherent qualities which the farmer, through many contacts, has come to recognize as desirable in a building material. Many farmers, if not using steel fence posts exclusively, have inserted them at intervals in the fence line to ground the fence, thereby protecting livestock from injury by lightning. Metal sheets used as a roofing or wall covering, or steel members used in the framing, if properly grounded, offer the same protection to buildings from the hazard of lightning. The resistance which steel construction offers to the start and spread of fire readily appeals to the farmer who is poorly equipped with means of fire protection.

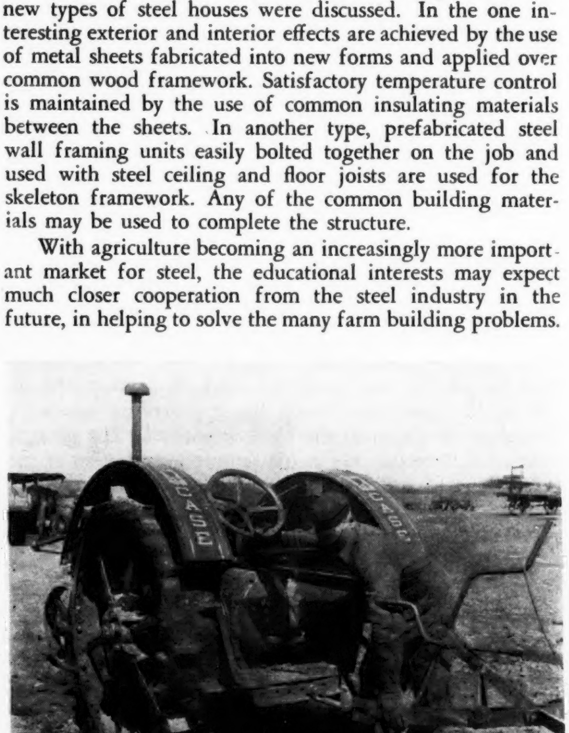
From the standpoint of sanitation and vermin and rodent control, steel is a highly desirable building material. The American Zinc Institute, through its extensive research and educational program, has brought to public attention the long years of service-life inherent in good zinc-coated metal building sheets. Low maintenance cost and permanence are too often overlooked by the farmer. Put in proper form, steel offers possibilities of speeding up the job of building erection, with resulting savings to the farmer.

Recent developments in improving the quality of metal sheets; the coating, method, and means of application; new paint for maintenance; and application with new insulating materials, have overcome many limiting factors in connection with their use.

A survey conducted by the writer indicates that the steel industry is taking a greater interest in the farm building field. Steel buildings are now available for almost every agricultural use. Steel grain bins have been in use for some time, as have steel silos. Steel hay storage units and all-steel barns are relatively new. Storage of hay in a steel building separate from that in which livestock are housed offers a promising means of reducing the enormous losses resulting from spontaneous ignition of hay. One manufacturer reports a good volume of sales of metal-clad barns using metal sheets, both inside and out, in conjunction with insulation material. Development of a complete line of flashing and trim, window frames and doors has contributed largely to increased use of such construction. This type of construction is also finding favor in remodelling existing structures where the frame is still in good condition.

In AGRICULTURAL ENGINEERING for May 1936, two new types of steel houses were discussed. In the one interesting exterior and interior effects are achieved by the use of metal sheets fabricated into new forms and applied over common wood framework. Satisfactory temperature control is maintained by the use of common insulating materials between the sheets. In another type, prefabricated steel wall framing units easily bolted together on the job and used with steel ceiling and floor joists are used for the skeleton framework. Any of the common building materials may be used to complete the structure.

With agriculture becoming an increasingly more important market for steel, the educational interests may expect much closer cooperation from the steel industry in the future, in helping to solve the many farm building problems.



Presented before the Farm Structures Division of the American Society of Agricultural Engineers at Chicago, Ill., December 2, 1936.

Author: Agricultural engineer, Republic Steel Corporation. Jun. Mem. ASAE.

Supplemental Irrigation in Humid Areas

By F. E. Staebner

THE agricultural engineer is concerned with the justification for supplemental irrigation installations, and he is often called upon to help the farmer with his decision as to whether supplemental irrigation may or may not be profitable. Although the question concerning the installation of supplemental irrigation is generally stated in its relation to profit, it is probably more desirable to think of it as drought insurance. Its principal function is probably to maintain farm yields, and therefore farm income, in seasons of drought.

Two committees of the American Society of Agricultural Engineers have made reports, one in 1931 and one in 1936, on the areas in various states equipped with supplemental irrigation. Table 1 is taken from these two committee reports using, in both cases, the same 17 states which lie definitely in the humid region. The estimate for 1936 is about three times as large as that for 1931, indicating that the belief in supplemental irrigation is fairly widespread. A further indication of this may be seen in Table 2, which is an assembled report showing contemplated extensions of irrigation systems by truck growers who have irrigated for not less than 3 years, and includes the last 16 truck growers contacted, who are known to have practiced irrigation for three years or longer. The total acreage irrigated in this group is 446, an average of 25 acres each, showing that these are rather substantial farmers. This group has practiced irrigation for an average of over 9 years each. As shown, seven of the 16 growers contemplate extension of their irrigation systems this autumn. Although 9 growers contemplate no extension of their systems, three of the 9 farmers now have their entire acreage completely equipped.

Table 3 shows the contemplated extensions of their irrigation systems by the last 6 orchardists contacted, who likewise have irrigated for 3 years or more. The total acreage now irrigated by these 6 farmers is 655, or an average of 109 acres of orchard each. These orchardists have practiced

TABLE 1. ESTIMATE OF ACRES IRRIGATED

	1931	1936
Minnesota	150	895
Wisconsin	40	340
Michigan	2,000	7,600
Iowa	1,000	1,000
Illinois	250	630
Indiana	1,756	550
Ohio	500	10,000
Delaware		10
Pennsylvania		300
New York		1,825
Maryland	5,700	1,150
New Jersey		6,000
Connecticut		355
Massachusetts		2,000
Rhode Island		200
Maine		98
Vermont		7
Total	11,396	33,060

TABLE 2. IRRIGATED TRUCK GARDENS

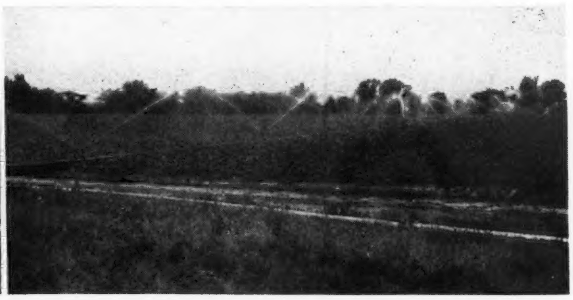
	Acres	Years	Extension Contemplated	
	25	5	Yes	
	9	19		No
	16	3		No
	12	6		No
	15	8	Yes	
	21	6	Yes	
	10	7		No
	40	7		No
	15	8	Yes	
	7	5	Yes	
	45	6	Yes	
	15	4		No
	30	6		No
	16	3		No
	20	26		No
	150 permanent	26	Yes	
Total	446	145	7	9
	Average 28 acres	9 years each		

TABLE 3. IRRIGATED ORCHARDS

	Acres irrigated	Years	Extension Contemplated	
	140	9	Yes	
	140	8	Yes	
	75	6		No
	75	5		.No
	140	5	Yes	
	85	3	Yes	
Total	655	36	4	2
	Average 109 acres	6 years each		

A combination of papers presented before the North Atlantic Section at Skytop, Pa., October 16, 1936, and the Soil and Water Conservation Division of the American Society of Agricultural Engineers at Chicago, Ill., December 3, 1936.

Author: Drainage engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture, Mem. ASAE.



(LEFT) PUMPING PLANT USED FOR SURFACE IRRIGATION OF SEVERAL ACRES OF TRUCK GARDEN. (RIGHT) SPRINKLING IRRIGATION WITH PORTABLE, FLEXIBLE-JOINT PIPE, AND LARGE-RANGE SPRINKLER HEADS

irrigation for an average of 6 years each. Four contemplate extending their systems this season.

Figures as to the effect of any particular condition or practice are always difficult to get hold of, probably because the farmer's bookkeeping is generally not complete enough to give the desired data. However, useful figures are occasionally secured, and Table 4, shows the irrigation results stated by five farmers as their average over a period of years.

TABLE 4. IRRIGATION YIELD INCREASES

Farm No.	Crop	Average increase	Cost	State
1	Apples	Several carloads	One carload,	Virginia
2	Apples		35 cents per bu	Virginia
3	Potatoes	100 bu per acre		Michigan
4	Spinach	233 crates per acre		New Jersey
5	Peppers	100 per cent		New Jersey

The 35 cents per bushel on apples from Virginia is the reported cost of the additional crop estimated to be due to irrigation. I believe a figure close to that had previously been reported from Ohio. The case of the first orchard reported in Table 4 is outstanding. Although the owner feels that the irrigation plant has already paid for itself several times over, this year he is harvesting the largest and best crop he has ever had. Special factors, not fully understood, may enter into the picture in this orchard, but it appears that since irrigation was first undertaken, there has been a continuous noticeable improvement.

Owing to variable climatic conditions, a single year's results must always be viewed with caution, but as they may have some bearing on the average results of a series of years' operation of an irrigation outfit, Table 5 is given.

TABLE 5. IRRIGATION RESULTS, 1936

Farm No.	Crop	Single year increases	State
1	Pears	More than $1.00 per tree	Michigan
2	Pears	Double quality	Ohio
3	Strawberries	200 16-qt crates per acre	Michigan
4	Melons	Larger and better quality	Michigan
5	Peaches	More than $100 per acre	Michigan
		Single year irrigation yield, 1936	
6	Strawberries	Gross $760 from one acre	Michigan

Assuming that irrigation is contemplated, a question arises as to the best type of irrigation to install. This is largely a matter of adjustment between the soil conditions, the available water supply, and the farmer's individual choice, provided that suitable crops are to be grown under suitable soil conditions, and that good markets are available. The importance of the individual who will operate the system should not be overlooked in estimating the probable success of any irrigation venture.

Each irrigation installation is an individual problem. Careful consideration should be given to the type of irrigation to be installed. Assuming that the crops to be grown respond well to irrigation, that they are sufficiently high-priced to warrant the expense of irrigation, and that good markets are available, attention can well be turned to the soil and topographic conditions. A soil that is neither extremely porous nor extremely heavy, and a slight but uniform slope is desirable for surface irrigation, although steeper slopes can be irrigated by surface methods, if necessary. Sprinkling irrigation has the advantage of being applicable to any type of soil and any topography. For subirrigation, a level or slightly sloping, porous topsoil, overlying an impervious subsoil, is necessary.

Subirrigation is perhaps the most attractive form of irrigation in the minds of most people. Where conditions are suitable it is an excellent type of irrigation, but it can be successfully used in so few localities in the United States that it is almost a mistake to include it in this discussion. The prime requisites for such irrigation are a suitably impervious subsoil at a proper depth, a porous top soil, suitable topography, and a plentiful water supply. The impervious subsoil should be located at a depth of from 18 in to 6 ft, according to the crop grown, the shallower depth for the shallower rooted vegetable crops, and the greater depth for orchards and deeper rooted crops.

A careful study of the situation occasionally warrants fitting a type of irrigation to a field that does not seem adapted to it. On the farm of a state institution at Newburg, Ohio, notable application of subirrigation was made about three years ago by Virgil Overholt of Ohio State University, at the request of J. D. Bragg, the agricultural adviser. In this case the tile lines were laid approximately only a rod apart, almost on the contours; a fall of 0.1 ft per 100 ft was allowed, and piped water provided through a valve at the higher end of each tile line. The superintendent of the institution reports excellent results from this installation, and believes that it uses less water than a sprinkling irrigation system covering an equal area on an adjoining tract. The system of operation is simply to turn on the water and let it run for about 30 min, or until a change in color shows a suitable amount of moist soil on the surface of the tract. This type of irrigation system should be lower in field construction cost than a sprinkling system, is easy to handle, and therefore is very desirable for use where suitable conditions exist.

SURFACE IRRIGATION FOR SIMPLICITY AND LOW INVESTMENT

The simplest system, and the least expensive, ordinarily is surface irrigation. This system, like all others, has certain limitations, the most important of which is the surface slope. Surface slopes must be sufficient to cause the water to flow, but not to cause erosion. In the humid region, where farmers are accustomed to see frequent heavy rains on their fields, they should make little error in judging this factor. In this territory, surface irrigation in its simplest form requires a pumping plant and a short pipe line. This condition is not often met, but an irrigation plant consisting of only a pumping plant and a fairly long pipe, is common. If the pipe line can be brought to the high part of a ridge it may be possible to run a head ditch on the top of the ridge to lead water both ways from the pipe discharge, and final distribution for truck crops may be made down the middles between the rows. Particularly does this work well if the slope down the rows is slight but quite uniform and the process of cultivation such that the middles between the rows are just slightly depressed. In well-cultivated crop land, a surface slope of 0.2 ft per 100 ft or less is satisfactory in many soils.

Such a head ditch as mentioned above is often impossible because of variations in surface slope, and it is also considered to be a handicap to the other field activities, whether installed as a permanent ditch or plowed in for each occasion. A head ditch may readily be replaced by a pipe line with suitable hydrants or outlets. From the outlets, hose or pipe may be used to deliver the water to the middles. Outlets about 80 ft apart, with 50-ft lengths of hose, is one rather satisfactory arrangement, the opening of the hose being moved from middle to middle as irriga-


(LEFT) ORCHARD IRRIGATION BY MEANS OF EYELET HOSE. (RIGHT) TROUGH USED FOR DISTRIBUTING IRRIGATION STREAM TO SIX FURROWS

tion progresses. Portable galvanized iron pipe, with gate openings at each middle, is also satisfactory in many arrangements. In other instances the distribution of water to the middles is accomplished by means of a trough with notches cut in one side, several middles being irrigated at one time.

In one case where a farmer uses this type of distribution, he brings water to a trough by means of a 2-in pipe on the surface of the ground, and couples an additional length of pipe as he moves the trough across the field. Another farmer, applying surface irrigation on a number of crops, including strawberries, is using a large-size canvas hose for delivering water to the field. This hose was made from strips of heavy waterproof canvas 24 in wide, resulting in a hose a little over 7 in in diameter. He reports finding this a satisfactory size, the matter of coupling one length to another being a simple matter by thrusting one end of the supply hose into the end of the receiving hose 2 ft or more and counting on the pressure of the water to hold the joint tight. He states that such a joint must be made with the hose lying straight on the ground to make certain that there is no slack on the line near the point of juncture. Furthermore, the assembly must be made when the hose is empty. A larger hose may be used satisfactorily to deliver water to one of smaller diameter, but the reverse arrangement would not be satisfactory.

This farmer uses hose up to 300 ft in length, and in moving the hose after it has been drained, he simply gathers it up loosely over one arm without attempting to coil or roll it. When he has occasion to move considerable hose equipment to another farm several miles away, he gathers it loosely in the same way into a light truck and upon reaching the other farm, connects the hose to the discharge point of the supply pipe and lets the truck move slowly down the field, paying out the hose over the end as the truck advances. This gives a rough set-up which permits him to start irrigation. He then lays out a second line of hose with care and thus is prepared to continue irrigation in good form after the irrigation from the first line has been completed.

A pile of this hose which was stated to be 8 years old had just been sewed the third time, because the thread had rotted out although the canvas seemed to be in good condition. This type of hose was reported to be satisfactory for use as conveyor hose up ridges as high as 3 ft or more. This farmer has also recently acquired 1,500 ft of portable, flexible-joint pipe of one of the more recently developed types which depends on a fishtail rubber gasket for making a tight connection. This type of pipe will stand considerable pressure and so may be used to get water to the top of many ridges that normally would require a separate permanent branch pipe line.

For the irrigation of orchards much the same conditions prevail, although the handling of the water in the orchards may be somewhat different. In the first place, a pump and pipe line are necessary. A good many orchards may be found with outlets several hundred feet apart, but apparently outlets closer together, up to every other tree row, are to be preferred. For such outlets many farmers use 2-in pipe with a cap over the end. Usually, in irrigating, several outlets are running at a time, and it is then a simple matter to remove a cap when irrigation from another outlet is desired, or to close up one when it is desirable to stop irrigation at that point. Often water is led to the middle between the trees at one side of such an outlet until the middle is thoroughly wetted and then the water stream is turned to the middle at the other side. In some instances, after removing the cap, a portable valve is put on in place of the cap so that the rate of delivery of water from that outlet may be controlled. Occasionally a valve and a short length of hose is used instead of hoe or shovel work to direct the water stream. Quite commonly the water, in its movement down the middle or down the tree rows, depending upon the irrigation practice in any particular orchard, is guided in its course entirely by hoe and shovel. Often the land is not cultivated between irrigations, nor are the little levees and channels built up by the hoe and shovel work disturbed during the course of the season. That makes irrigation a simpler task each time the water is applied.

ADAPTATION OF PRACTICE TO MEET SPECIAL CONDITIONS

Cases are frequently found where careful study has resulted in unusual excellence in suiting the irrigation plan to existing conditions. Among such may be noted an irrigated orchard in Ohio where a farmer has worked out an unusual scheme of final distribution. The trees had originally been set on mounds in planting. It is desirable to get water as near as possible to the big mass of roots near the trunks of the trees. In this instance it was a problem to get much water there because of the mounds. Accomplishment of this was further complicated by sloping ground in a part of the orchard. It was solved by making basins around the trees by means of a California orchard cultivator especially altered for this purpose. The outfit, dragged three or four times around the tree by means of a tractor, throws up a ridge forming an approximately circular basin around the trunk of each tree, about equivalent in diameter to that of the drip line of the tree. On the more steeply sloping part of the orchard it is impossible to get water to the soil on all sides of the tree by merely allowing it to be

ponded by the circular levees, and in many instances it is necessary to put in one or sometimes two levees across the circular basin. When any basin has become well filled, a cut is made in the levee to let water on down to the next basin. According to conditions, the levee may be cut to a depth sufficient to let out all the ponded water, or the cut may be only deep enough to let the excess water flow out while still retaining a certain depth of water in the basin. The water set free by this opening in the levee is, in either case, permitted to run down to the next basin or part basin and fill that. It is sometimes necessary to dig a shallow shovel ditch to guide the water from tree to tree, and sometimes it is necessary to construct little levees to make the water follow the desired course down to the next basin.

Under certain conditions, more especially on the sandy soils of Michigan and Ohio, as well as in places where the surface slopes are steep, some orchardists have found or have realized that it is essential to obtain better confinement of the water stream up to the point of delivery to the crop than can be secured by any surface method. A number of attempts were made to apply porous hose in this work. Porous hose had been successfully used in irrigation of truck crops and some orchardists have been irrigating with porous hose. In some instances really low cost of irrigation, and particularly low cost of increased crop due to irrigation, have been reported. However, certain inherent difficulties seem to have prevented the spread of this exact type of irrigation and have led to the development of eyelet hose.

SPECIAL EQUIPMENT AIDS TO APPLICATION OF WATER

Eyelet hose is commonly made to a diameter of nearly 3 in, with four small eyelets placed around the circumference at intervals of 2 ft. This hose is preferably made of waterproof canvas, and differs from porous hose in that the latter is waterproofed only in the fibers. Eyelet hose offers a controlled conveying channel with frequent delivery points along its line. No matter how the hose may lie, at least two outlets every 2 ft are open for the free discharge of water, and these under considerable pressure may throw streams to a distance of 7 or 8 ft each side. This throwing of the spray to wet a strip 14 to 16 ft wide makes it possible, as a usual thing, to irrigate each middle in an orchard with one placement of the hose. The best figures available at present indicate that 10 gal per min per 100 ft of hose is a reasonable allowance for the quantity of water that will be discharged by eyelet hose under ordinary conditions. This type of hose, as commonly used, is made in 200-ft lengths, with special brass connecting pieces threaded with standard 2-in pipe thread. Lengths of 400 ft are ordinarily satisfactory.

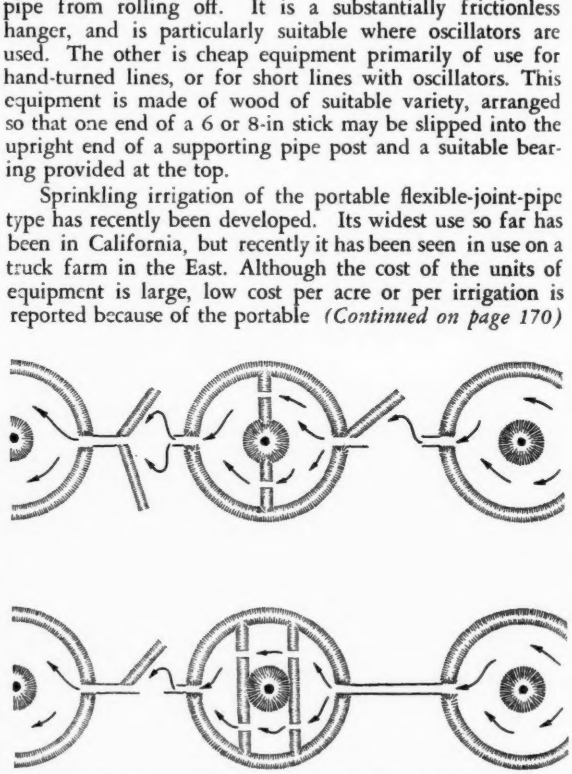
On some of the lower-growing truck crops and on strawberries, porous hose irrigation is used to a considerable extent. Its widest use apparently is on row crops where the hose is laid down the middles between the rows, and on strawberries where the hose may be laid either in the middles or directly on top of the berry plants. Experience seems to indicate that its greatest usefulness comes on sandy soils and in places where the water supply is limited. It may be used for irrigation of home gardens on heavy soils which absorb water slowly, but present indications are that on such soils this method is not practical on a commercial scale, because of the large investment in hose necessary to run enough lines to supply water at a satisfactorily rapid rate under ordinary field conditions.

Moving porous hose from row to row involves a large amount of arduous labor. The commonest practice in moving this hose is to use a hand wheel, but there are also a number of installations in which the hose is moved by hand, a short section at a time, or is lifted from position to position by means of a hoe. A line of porous hose may be expected to wet a strip of soil 16 to 30 in wide.

Overhead pipe sprinkling irrigation seems to be pretty well standardized and few changes have recently been noticeable. It begins to appear, however, that the greatest number of installations are now using a height of 4 to 4.5 ft above the ground for the sprinkler pipes. A number of installations have been observed where pipes previously set at a higher position have been lowered, and some that were set lower have been raised. It seems that 4 to 4.5 ft is a satisfactory height both from the standpoint of cultivation, whether by mule or garden tractor, and also from the standpoint of cleaning clogged nozzles or servicing oscillators. The use of oscillators is increasing and apparently compact oscillators are preferred, as the longer ones, if left in an unfavorable position, get snagged and damaged during cultivation. A surprising number of installations are providing oscillators for every nozzle line but this seems an unnecessary expense. It is believed that most of the objections to portable oscillators come from the fact that very few irrigators equip themselves properly for the ready installation or removal of such apparatus, the commonest arrangement being to thread and unthread the oscillator into and out of position. Satisfactory hand-operated coupling fittings are available, by means of which the oscillator may be placed in position and water-tight connections made without the use of tools.

Two useful devices for holding the sprinkler pipes on top of supporting posts might be noted. One is an aluminum bar hanger. It simply is a flat bar on which the pipe may roll in oscillating, with ends turned up to keep the pipe from rolling off. It is a substantially frictionless hanger, and is particularly suitable where oscillators are used. The other is cheap equipment primarily of use for hand-turned lines, or for short lines with oscillators. This equipment is made of wood of suitable variety, arranged so that one end of a 6 or 8-in stick may be slipped into the upright end of a supporting pipe post and a suitable bearing provided at the top.

Sprinkling irrigation of the portable flexible-joint-pipe type has recently been developed. Its widest use so far has been in California, but recently it has been seen in use on a truck farm in the East. Although the cost of the units of equipment is large, low cost per acre or per irrigation is reported because of the portable *(Continued on page 170)*



CIRCULAR BASINS, WATER CHANNELS, AND LEVEES USED IN IRRIGATION OF AN APPLE ORCHARD IN OHIO

Erosion Control Along Highways

By Arnold Davis

DURING the past few years a new idea has come to highway engineers, which when fully developed and put into actual operation with all new construction, will solve most of the problems of making a safe highway, as well as of roadside stability and beautification. This idea is erosion control along highways, the proper handling of runoff waters.

From past observations it has become generally known that where roadside ditches were left raw and unprotected from rushing runoff waters, they were cut deep, and in many cases this resulted in damage to the highway surface. Such ditches produced a dangerous hazard to the automobile traffic and were expensive to repair. Protection against ditches with guard rails proved dangerous as well as expensive. Engineers found that these roadside ditches attained a gradient from the culvert floor, which was placed far beneath the surface in order to care for the drainage. Development to guard against deep ditches along highways brought about the use of the drop inlet and the "broken back" culvert, and the location of culverts above the low point, along with numerous other features, all of which tended to prevent excessive soil losses from highway embankments and right of ways.

Even after the ditch lines were raised the problem was not solved, since in numerous cases the grade of the ditch was above five per cent, and the velocity of the runoff water still caused a serious soil loss. The old practice of "pulling" ditches in order to insure flash runoff simply laid them open to excessive erosion. This practice was soon abandoned.

Highways or roads act as diversion terraces, which cause the water to concentrate at the culvert cross drains. This, of course, cannot be completely remedied, although such concentration of water has been a big factor in the flooding of streams and the ruin of agricultural lands adjacent to highways.

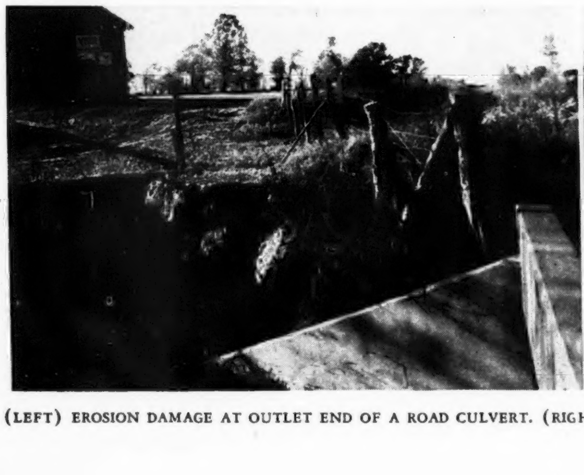
In Region 4 of the USDA Soil Conservation Service, which includes the states of Louisiana, Arkansas, and Texas, except the high plains region, there are over one-half million miles of road ditches, in the construction of which practically no consideration was given to the problem of erosion. The quantity of soil that has been removed from these ditches by rushing rain waters is enormous and most of it was unproductive subsoil which has been deposited over highly productive lowlands.

Insufficient right of way may be pointed to as one of the principal causes contributing to severe highway erosion. A completely safe and stable highway cannot be constructed on a ribbon right of way. Nor can complete erosion control be obtained along highways that do not have wide rights of way. To secure a safe highway, and certainly to assure erosion control, it is necessary that slopes be flattened and that outside water be either diverted or brought onto the right of way over a protected area. Ditches must be changed into drainageways and designed for a desired velocity to prevent scouring and to minimize silting. As the velocity of runoff water increases beyond a safe point, the drainageway should be widened, not deepened. Flat-bottom ditches must be used in the place of the V-bottom ditch which is more susceptible to erosion. Drainageway elevation should be kept high in reference to the center line of the highway and designed to allow at least 6 in of free board, based on the maximum probable rainfall intensity of 50-year frequency. Also the drainageway should be kept away from the subgrade or base. This is especially true on flexible base roads.

The Soil Conservation Service has offered to cooperate with state highway departments in establishing a number of highway erosion-control areas in Region 4. The USDA Bureau of Public Roads has also displayed an interest in such areas, and will approve the expenditure of funds through the regular federal aid program in order that this work may get under way.

Highway erosion control areas in Louisiana, Arkansas, and Texas, as now outlined, are cooperative projects between the Soil Conservation Service and the respective state highway departments. The general plan adopted in Region 4 is for the highway department to furnish materials and construction machinery, and the Soil Conservation Service to furnish supervision and available labor. The plan of work is to conduct erosion control projects on the representative soil types in those regions in the three states where

Author: Associate agricultural engineer, in charge of cooperative operations in highway erosion control, Soil Conservation Service, U. S. Department of Agriculture, Region 4.



(LEFT) EROSION DAMAGE AT OUTLET END OF A ROAD CULVERT. (RIGHT) ROADSIDE DITCH BANK SLOPE TO BE FLATTENED AND VEGETATED

highway erosion is a severe problem. It is anticipated that the data gathered from these areas will furnish information that will be applicable and of practical value in highway erosion control work in similar larger areas.

The projects will be definitely planned before construction is started, and numerous methods will be used, in order that a final decision may be reached as to the treatment to be recommended for areas where conditions are about the same. Methods used in carrying out the projects will vary in treatment as to the kind of sod, method of revegetation, use of topsoil and fertilizers, and use of nurse crops for protection of the soil until nature can spread a permanent cover of native grasses. Waterways will be designed for desired velocity, and unprotected overfalls will be eliminated. Drainage structures, endangered by encroaching gullies, will be protected by the use of vines or mechanical means. The use of intercepting terraces, constructed on non-erosive grades, will be demonstrated. All ditches will be eliminated, even to use of the word itself. "Drainageways" and "waterways" will be the terms used.

One project in Arkansas is located in the Crowley Ridge area, along a stretch of highway extending 2.5 mi from the city limits of Forrest City. The soils in this region are wind blown or loessial and alluvium, and are included in the Memphis, Lintonia, Olivier, Lexington, Calhoun and Grenada series. This area is subject to severe water erosion. The subsoil in the region is about 50 per cent as productive as the topsoil, which makes it easy to grow vegetation, but due to the highly erodible surface and subsoil materials, it is very difficult to hold in place until vegetation can be established. An extensive use will be made of the U-type drop inlet, which will raise the elevation of the drainageways to produce grades not exceeding those of the road.

Methods used in establishing the Bermuda grass, which will serve as a permanent cover, will be varied over the project area. On all except the check sections, commercial fertilizer will be used with winter cover crops of Abruzzi rye, red May wheat, winter turf oats and Italian rye grass. These winter nurse crops will be followed, in some sections, with a spring cover of hop clover and lespedeza, in order to determine whether the native permanent cover will need additional protection. The cost of seeding these crops will be low, in comparison to sodding, and it is believed that economical erosion control can be best obtained by doing a small amount of transplanting and allowing nature to spread the Bermuda grass to a complete cover under the protection of a nurse crop.

Just how the transplanting of the Bermuda grass should be done, amount of fertilizer to be used, and the kind and amount of nurse crop necessary will be determined after the complete cover is secured. A definite answer will also be obtained as to the most economical method of controlling erosion by use of vegetation on different slopes, for the particular soil type and climatic conditions, and identical construction season.

A detailed record of existing conditions along the different sections making up the demonstration areas in Arkansas, has been compiled. The results of the work on each section will be compared with the original conditions as the projects are inspected periodically during the progress of the work and after completion. Data will be obtained as to growth of nurse crops, spread measurements of the permanent cover, fertilizer injury, if any, an estimation of soil loss, and repair work required. In short, these periodic reports will include all pertinent data for a complete analysis of the projects. With this analysis and final recommendations, together with an accurate cost sheet, valuable information should be obtained on highway erosion control that will be of benefit to the highway department and to the public.

Supplemental Irrigation in Humid Areas

(Continued from page 168)

feature. Irrigation equipment of this type has been obtained for as low as $30 to $40 per acre, including the cost of pumping equipment, and, in the case of the eastern installation just referred to, the owner estimated that he was able to apply a 2-in irrigation for $3 per acre. Two or three types of quick-assembling joints are used. At least two of these systems use a fishtail rubber gasket to make a tight joint, and one uses a ball-and-socket connection.

Nozzles of the whirling spray type are commonly used, and can be obtained in various ranges of coverage, but unless the crop requires that the water be broken up into very fine droplets, sprinklers of long range are to be preferred. Sprinklers with a range as large as 50 ft in radius may be used.

In irrigation of this type sprinklers observed apparently had a satisfactory coverage of perhaps 27 or 28-ft radius. As the system was being used, every other fitting was plugged or capped and a sprinkler was attached to every other one. As the pipe lengths were 20 ft, the sprinklers were placed at 40-ft intervals along the pipe. The farm using this outfit had two irrigation units, each consisting of a portable two-wheeled pumping outfit on rubber tires, 500 ft of 6-in main or header pipe, and 1,000 ft of 4-in distribution or sprinkler pipe, and 25 sprinklers. On the day of inspection, the outfit was being used in irrigating spinach. The distributor pipe with the sprinklers in operation was left in one position for two hours and then the engine was shut down and the pipe moved to a new and parallel position 60 ft away from the previous one. A moving crew of four men carried three lengths of pipe at one time, one man being located at each pipe end. This arrangement provided a man always in the right position to protect a sprinkler from being dragged on the ground, and also provided a man at the end to attend to disconnection from the pipe previously used and one at the assembling end for relaying. This outfit uses a snap hook connection to prevent the pipes blowing apart when pressure is applied to the line.

This farm operates on two 12-hr shifts but arranges to have one crew operate the two units. The owners feel that, in a period of continued drought, each unit has a capacity of about 35 acres if the outfit is operated 24 hr per day and they contemplate returning to the first position to start over at the end of a ten-day period. Each unit uses about 2.5 gal of gasoline per hour.

This farm is favorably situated for this type of irrigation in that it adjoins a river for a considerable distance and, furthermore, several creeks run through the place allowing opportunities for setting up the equipment. There is a 4-ft rise and fall in tide to contend with, but the water is never brackish. In most positions where the pumping unit is set, a small amount of grading has been necessary to get the pipe line up the bank.

NEWS

Preliminary Annual Meeting Program

GENERAL plans for the 31st annual meeting of the American Society of Agricultural Engineers at the University of Illinois are definitely arranged, and the meetings and local arrangements committees are rapidly rounding out the details.

Registration of early arrivals will begin Sunday afternoon June 20. As usual, the College Division program is scheduled for the first day of the meeting, June 21. General sessions will be limited to two one and one-half-hour periods starting the meetings on Tuesday and Wednesday, June 22 and 23. Technical division sessions will occupy the remainder of those two mornings and Thursday morning June 24.

Afternoons have been left open for individual contacts, inspection trips, and special group meetings. The Annual Dinner is to be held Wednesday evening and is to be followed by a dance. Other entertainment features planned include an illustration lecture on Sunday evening, a picnic on Monday evening, an educational plow exhibit on Tuesday afternoon, and illustrated talks on Tuesday evening. Special entertainment is being planned for women and children during other hours.

Education, extension, and research are all scheduled for group discussion in the College Division session. Curricula, subject matter, service courses, summer camps or courses, administration, graduate work, relations with the Society for the promotion of Engineering Education, and agricultural engineering work are to be discussed in the opening program devoted to education. Agricultural engineering extension is to be covered from the angles of relation to other extension work, extension methods, educating employees of agricultural engineers, the vocational program, the 4-H Club program publications, and the USDA Bureau of Agricultural Engineering. Research consideration will be concentrated on project presentation, graduate research, and experiment stations.

In addition the committee on extension and the student group have scheduled special sessions to run concurrently during a part of the main meeting.

Tuesday morning's general session will feature formal opening of the meeting, an address of welcome, the President's Annual Address, and one outside speaker.

Another outside speaker and the recipient of the McCormick Medal Award are each to address the general session on Wednesday morning.

Technical division programs have been built up by the several chairmen and representative groups of members. The Farm Structures Division will feature farm housing; agricultural engineer's responsibility in the promotion of better farm buildings, and papers on individual structural problems and developments.

Power and Machinery Division attention is to be centered on "The Farm Tractor Fuel Problem," "Quick Attachable and Detachable Power Farming Equipment," and "Natural and Artificial Curing of Forage Crops."

The Rural Electric Division will offer sessions on extending electric service in rural areas, assisting the farm customer, and electric service for the farm family.

In the Soil and Water Conservation Division a wide variety of irrigation, drainage, erosion control and land use problems are slated for consideration.

The Annual Business Meeting of the Society is scheduled for 4:00 to 5:00 p.m. on Wednesday, June 23.

Headquarters and registration center for the meeting will be in the Women's Building on the University of Illinois Campus. Downtown headquarters will be at the Urbana-Lincoln Hotel.

Subjects tentatively scheduled in detail by days and divisions, are as follows:

Monday, June 21. College Division—(1) Discussion of Education—Agricultural Engineering Curriculum—Four, Five or Six Years, Agricultural Engineering Administration, Subject Matter in the Agricultural Engineering Curriculum, Summer Camps or Courses, Service Courses in Agricultural Engineering—Agricultural and Vocational, What are Agricultural Engineers Doing?, Who Does the Agricultural Engineer's Work, and SPEE and ASAE. (2) Discussion of Extension—Extension Work and Agricultural Engineering, Extension Methods, Educating Employees of Agricultural Engineers, Vocational Program, 4-H Club Program, Publications, and Bureau of Agricultural Engineering, USDA. (3) Discussion of Research—Project Presentation, Graduate Research, and Experiment Stations.

Tuesday, June 22. Farm Structures—(1) Design Factors for Small Farm Houses, (2) Farm House Design from the Standpoint of Architectural Beauty, and (3) Use of Insulation Under High Humidity Conditions.

Power and Machinery—The Farm Tractor Fuel Problem—(1) The Fuel Situation from the User's Standpoint, (2) The Tractor Fuel Problem from the Refiner's Viewpoint, and (3) Proposed Standardization of Tractor Fuels.

Rural Electrification—Problems and Procedure in extending Electric Service in Rural Areas—(1) Helping Farm Prospects in a State Determine Needs and Prepare for Electric Service, (2) Analysis of Factors Involved in Rural Electric Service, (3) Getting Adequate Wiring Installations on Farms, and (4) Electrification of Rural America—Status and Problems.

Soil and Water Conservation—(1) Irrigation by Sprinkling, (2) The Status of Land Drainage in the United States, (3) Stream Bank Protection, and (4) A Desilting Device for Irrigation Canals.

Wednesday, June 23. Farm Structures—The Agricultural Engineer's Responsibility in the Promotion of Better Farm Buildings—(1) Why Have Better Farm Buildings?, (2) Farm Structures Research as a Basis for Promotion, (3) Industry's Contribution to Better Farm Buildings, and (4) Organization for the Promotion of Better Farm Buildings.

Power Machinery—Quick Attachable and Detachable Power Farming Equipment; or (1) Engineering—Management Studies in Corn Production, and (2) Proposed Standardization of Row Crop Spacing.

Rural Electrification—Assisting the Farm Customer to Enjoy the Benefits from Full Use of Electric Service—(1) Successful Educational Programs with Farm Groups, (2) A Sound Utilization and Load Building Activity, (3) A Seasonal Plan for Rural Electrification Development, (4) Light—Possibilities and Opportunities on the Farm, and (5) Economic Justification for Electrical Equipment on the Farm.

Soil and Water Conservation—(1) Management and Use of Agricultural Lands, (2) Highway Erosion Control Problems, (3) Erosion Control Problem of the Railways, and (4) Terracing Extension Methods in Alabama.

Thursday, June 24. Farm Structures—(1) Heating, Ventilating, and Humidity Control in Tobacco-Curing Barns, (2) Results of Recent Research in Spontaneous Combustion, (3) Utilizing the Structural Value of Insulation in Poultry House Construction, (4) New Developments in Roofing Nails, and (5) Progress of the Fence Testing Project.

Power and Machinery — Natural and Artificial Curing of Forage Crops—(1) Forage Curing Problems: A Challenge to Engineers, (2) Farm Experience in Forage Curing, (3) An Equipment Development for Forage Curing, and (4) A Review of Recent Progress in Natural and Artificial Forage Curing.

Rural Electrification—What Electric Service Is Doing and what it can do for the Farm Family—(1) Electricity and Engineering Phases of Dairy Farming, (2) Electricity and Fruit Farm Operations, (3) Electricity and the Farm Home, (4) Electricity and Insect Control, (5) Irrigation—Crop Insurance, (6) Farm Cold Storages, and (7) The Drying of Hay and Other Farm Crops.

Soil and Water Conservation—(1) An Extension Program in Soil and Water Conservation Work, (2) Special Problems Encountered in Soil Conservation Work, (3) Results of Experimental Studies in Soil Conservation, (4) Terrace Project Planning, (5) Studies of Machinery in Relation to Erosion Control Work, and (6) Mechanical Methods of Water Conservation on Pasture Land.

"Penn State Farmer" Features Agricultural Engineering

AGRICULTURAL ENGINEERING is featured in the March 1937 issue of the "Penn State Farmer," agricultural college student publication. R. U. Blasingame, A. W. Clyde, John R. Haswell, L. J. Fletcher, G. A. Rietz, Arnold P. Yerkes, and John E. Nichols are leading contributors.

ASAE Officers for 1937-38

As a result of the annual election of officers of the American Society of Agricultural Engineers just held, the new officers chosen to take office following the annual meeting of the Society to be held at the University of Illinois, Urbana, June 21-24, are as follows:

President, Arnold P. Yerkes, editor "Tractor Farming," International Harvester Company.

First Vice-President, F. C. Fenton, professor of agricultural engineering (head of the department), Kansas State College.

Second Vice-President, E. C. Easter, agricultural engineer, Alabama Power Company.

Councilor, C. E. Ramser, senior soil conservationist, Soil Conservation Service, U. S. Department of Agriculture.

Raymond Olney, also Secretary of the Society, was reelected Treasurer.

The new Council of the Society for the year 1937-38 will include the above-named officers, together with Q. C. Ayres and H. B. Walker, councilors; L. F. Livingston, senior past-president and R. U. Blasingame, junior past-president. The newly elected Nominating Committee of the Society consists of F. J. Zink, (chairman), E. M. Mervine, and M. M. Jones.

SAE Tractor Meeting Features Engines

Power plants for agricultural tractors from an automotive standpoint will be featured in the SAE Tractor Meeting to be held in Peoria, Illinois, April 21, 22, and 23, at the Hotel Pere Marquette. The Society of Automotive Engineers extends a cordial invitation to all interested ASAE members to attend.

According to the advance program, papers scheduled for the first morning are (1) "Crankcase Ventilation and Sludge," by W. W. Lowther, and (2) "Effect of Addition Agents in Lubricating Oil on Piston and Ring Performance," by C. M. Larson.

A luncheon as guests of the Caterpillar Tractor Company is scheduled for 1:00 p.m., and the afternoon is given to an inspection of the Company's plant and field demonstrations.

Papers on Thursday morning's schedule are (1) "Diesel Engines for Agricultural Purposes," by M. J. Murphy, and (2) "Fuel Injection Equipment," by H. C. Edwards. The Caterpillar plant visit and field demonstration is to be continued in the afternoon.

Friday morning papers will be (1) "Resistance Electric Welding," by E. A. Mallett, and (2) "Some Factors Affecting Design and Performance of Diesel Fuel Injection Equipment," by G. C. Riegel. A paper on "Servicing of Multi-Cylinder Diesel Engines," by R. J. Kretz, is scheduled for the afternoon, in addition to a short tractor activity business session.

Washington News Letter

from American Engineering Council

Public Works Administration figures having to do with work completed or being done with PWA assistance on irrigation, power, navigation, flood control, and all water supply for domestic and industrial purposes are enormous. They claim that the greatest water impoundment program in the world's history is being carried out in the United States through the PWA. All of the water held at one time in dams and reservoirs under this program would "cover the state of Pennsylvania with two feet of water, with enough left over for a few good sized lakes," or "supply New York City for sixty-two years with sufficient water for its requirements for washing, drinking, and industrial use," or "float 1,078,431 vessels the size of the British ship Queen Mary." It is estimated that the United States is about to impound 22 trillion gallons of water in places where it is thought to be most likely to serve the greatest number of people.

Army engineers and PWA officials are proud of the protection afforded the lower Mississippi Valley by levees, revetments, and permeable dikes; and feel that the recent prevention of floods in that area justifies the PWA allotment of $44,000,000. Altogether the PWA is reported to have allotted more than $250 000,000 toward the construction of dams and reservoirs and otherwise safeguarding waterways in the valley of the Mississippi and its tributaries. Every project which has reached the completion stage is reported to have successfully withstood the raging currents of recent weeks and to have prevented the loss of many lives and millions of dollars in property.

Prevention of the repetition of great flood losses presents a problem which engineers may well consider in connection with a new coordinated public works policy and a national water program recommended to the President by the National Resources Committee in December 1936, and recently transmitted to the Congress. It is an engineering problem of national scope likely to have serious consideration and to involve enormous sums of public funds.

* * *

Public Works Administration now officially claims to have created 2.5 times more work in private industries supplying building materials than in the building trades and construction labor on the site. They are supported by the results of a two-year study by the Bureau of Labor Statistics which fixes 2.5 to 1 as the correct ratio. Against 505,751,800 man-hours on the site, PWA projects have also provided 1,264,379,500 man-hours in forests, mines, mills, factories, and transportation. These are average figures. On power plants, for instance, the ratio is reported to be 4.4 to 1.

Of the total man-hours referred to above, the housing division created 9,800,000; the non-federal program, 505,751,800; and the federal program 726,263,000. If all of these figures should be made to carry the 2.5 ratio which the Bureau of Labor Statistics has reported, statisticians say that the total direct and indirect man-hours for all PWA programs would probably exceed 4.25 billions. None of these statistics considers the "secondary indirect" work created by the Public Works Administration.

An interesting byproduct of this study, which included contacts with more than 40,000 contractors and subcontractors, are other ratios and unit cost figures. Approximately 6 tons of basic materials are required for each ton of finished steel and, in addition to the 23 man-hours created in the extraction and transportation of the basic commodities, fabrication requires from 6 to 58 hours of labor per ton, depending upon the type of production. Cement production uses 126.3 man-hours per 100 barrels.

An additional large amount of "behind the lines" employment in production of consumers' goods could not be included in these calculations. Such employment came from the manufacture of clothing, food, and other consumers' goods required by those people employed on construction sites or in material production. The increased volume of such work was not calculated by the Bureau of Labor Statistics, but the so-called secondary effects involving the stimulation of industries and professions supplying consumers' goods and services, resulting from the increased buying power of reemployed workers, obviously is extensive.

ASAE Meetings Calendar

June 21 to 24, 1937—Annual meeting of the Society—University of Illinois, Urbana-Champaign

Personals

Edwin K. Bonner, Jr., has just become associated with A. B. Farquhar Company, York, Pennsylvania, and is working on the design of farm machinery. He was formerly a designer with John Deere Plow Works.

G. B. Hanson has been appointed agricultural engineer on the staff of the Cement Products Bureau, Portland Cement Association, Chicago, to be in charge of work seeking to contribute to the solution of problems in connection with practical and up-to-date farm uses of concrete. He was more recently a project engineer for the Resettlement Administration.

M. R. Lewis, irrigation engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture, has been assigned temporarily to assist in the organization of a state water conservation commission for North Dakota whose function it will be to investigate and construct irrigation and other conservation projects in the state.

Henry N. Luebcke has been appointed assistant engineering aide in the USDA Bureau of Agricultural Engineering, and will be stationed at Bowling Green, Ohio. He was formerly junior agricultural engineer in the Soil Conservation Service.

George R. Shier is now engaged with the division of structures of the USDA Bureau of Agricultural Engineering, and is located at Ohio State University, Columbus, Ohio.

Necrology

David LeRoy Yarnell, senior drainage engineer, U. S. Bureau of Agricultural Engineering, passed away suddenly at his home, Iowa City, Iowa, on March 9, 1937.

Born and educated in Iowa, and holding degrees from Iowa State College and the University of Iowa, Mr. Yarnell spent the early years of his professional life acquiring in the field a firm foundation upon which to build a lasting reputation in his chosen profession of hydraulic engineering. Starting work with the Department of Agriculture in 1909, he devoted seven years to special investigations and surveys of drainage and flood control projects in various sections of the country. In 1916 and 1917 his experiments, conducted at Arlington, Virginia, on the flow of water in drain tile, foretold the work which was to bring to him world-wide recognition in experimental hydraulics. More than 800 distinct tests were carried on with an unrelaxed attention to detail which characterized all of his work. No other work on this subject has commanded greater confidence from hydraulic engineers.

In 1922 Mr. Yarnell was placed in charge of hydraulic investigations at the hydraulic laboratory at the University of Iowa, the work being carried on under cooperative agreement between the Bureau of Agricultural Engineering and the University. His first major investigation under this assignment dealt with flow of water through culverts. In a two-year period, 3300 tests of culverts ranging in size from 12 in in diameter to 4 ft square were conducted at the laboratory. This study has been acclaimed by engineers in all parts of the world.

In 1929 he made tests by means of models to determine the benefits of proposed cutoffs on the Des Moines River at Ottumwa, Iowa. This study was probably the first attempt in the United States to determine in advance of actual field construction the benefits to be derived from straightening rivers. Mr. Yarnell was among the first of American engineers to recognize the value of river model studies, which have since been accepted as a necessary part of virtually every major hydraulic engineering project in America.

In 1933 the American Society of Civil Engineers conferred upon Mr. Yarnell the James R. Croes medal for a paper, entitled "The Effect of Turbulence on the Registration of Current Meters," which he prepared in collaboration with the late Prof. F. A. Nagler.

Mr. Yarnell was the author of a bulletin on rainfall frequency-intensity data, published in 1935, in which he made an analysis of 28,077 rainstorms representing the combined record of every weather bureau station equipped with automatic raingage, in the continental United States, from its beginning to the end of 1933. He showed exceptional patience in his analysis of this staggering tangle of statistical data, and brought usable order out of it.

More than 25 papers and bulletins are directly credited to his authorship. Countless others bear acknowledgment to him for his kindly interest and assistance. To his co-workers and to young men entering upon the study of engineering he gave most generously of his wealth of knowledge and professional experience. His support of the Iowa hydraulic laboratory during its early years was a large factor in its rapid development and his use of graduate students as his assistants was extremely beneficial to scores of young men in enabling them to continue their studies while gaining practical experience in hydraulic engineering.

A sensitive man, courteous, mild-mannered, and retiring, "Dave" Yarnell was genuinely loved by those who came to know him well, and was held in high esteem by all those who made his acquaintance.

On August 24, 1914, Mr. Yarnell married Miss Alice Lee Roche of Washington, D. C. He is survived by his widow; two sisters, Mrs. W. P. Bair of Des Moines, Iowa, and Mrs. Henry Weber of Pasadena, Calif.; and two brothers, Admiral Harry E. Yarnell, U. S. N., Commander of the Asiatic Fleet, and Ross Yarnell Shearon of Fergus Falls, Minn. Mr. Yarnell was a member of the American Society of Civil Engineers, the American Society of Agricultural Engineers, Iowa Engineering Society, Tau Beta Pi, Sigma Xi, and other scientific and professional organizations.

* * *

Morris Cotgrove Betts passed away at his home, 437 Cedar St., N. W., Tacoma Park, D. C., on December 22, 1936, at the age of 61, after an extended illness. Mr. Betts was born at Cincinnati, Ohio, on January 24, 1875. After completing his professional training at the School of Architecture of the University of Pennsylvania, he practiced with three leading architects in Philadelphia. Then he joined the staff of the "Ladies' Home Journal" as architectural editor. This led him to an interest in farm structures and a connection with the U. S. Department of Agriculture in 1914, where he conducted research in many phases of farm-buildings design and construction. When the Bureau of Agricultural Engineering was established in July, 1931, Mr. Betts was put in charge of the Division of Plans and Service. Under his direction were prepared a number of publications dealing with various problems of farm buildings, and designs of laboratory and service buildings at many Government field stations, including Arlington, Virginia; Beltsville, Maryland; Government Island, California; Portland, Oregon; Vancouver, Washington; and Ogden, Utah. During the World War he was detailed for service with the War Industries Board, where he assisted Bernard M. Baruch in preparing plans for emergency construction of small houses. He retired from active work in February 1936. He became a member of the ASAE in 1923. Survivors are Mrs. Helen Pennington Betts; a daughter, Mrs. Robert C. Elderfield, of Dobbs Ferry, N. Y.; a son, John M. C. Betts of Cambridge, Mass.; and a sister, Miss Alice C. Betts of Cincinnati, Ohio.

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the March issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Rollie N. Blancett, junior civil engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Calhoun, Ky.

John H. Burgess, junior civil engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Missouri Valley, Iowa.

Robin H. Burnette, junior agricultural engineering aide, Soil Conservation Service, U. S. Department of Agriculture. (Mail) ECW-20, Ramseur, N. C.

Joseph W. Burton, camp engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Damascus, Ark.

Stanley A. Collins, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Eldora, Iowa.

Oliver C. Cope, engineering aide, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) 605 S. Fifth St., Watseka, Ill.

John C. Cotton, junior engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Beltsville, Md.

Roy D. Crist, junior soil surveyor, Soil Conservation Service, U. S. Department of Agriculture. (Mail) RFD No. 2, Brewster, Kans.

Lawrence B. Dankbar, assistant engineering aide, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Camp D-1, Canton, Mo.

Arnold M. Davis, associate agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) N. P. Anderson Bldg., Fort Worth, Tex.

Harry G. Davis, director of research, Farm Equipment Institute, 608 S. Dearborn St., Chicago, Ill.

Robert M. Dill, sales and service department, John Deere Harvester Works, East Moline, Ill. (Mail) 539 17th Ave.

J. P. Distler, manager of sales, wire division, Republic Steel Corporation, 7850 S. Chicago Ave., Chicago, Ill.

H. M. Ellis, extension agricultural engineer, North Carolina State College, Raleigh, N. C. (Mail) Box 5157, State College Station.

R. L. Farmer, underengineering aide, Resettlement Administration. (Mail) Box 181, Enterprise, Ala.

J. Ivan Fredregill, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 610 Washington Ave., Red Oak, Iowa.

Herbert D. Fritz, assistant drainage engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) University of Illinois, Urbana, Ill.

Elmer W. Gain, administrative engineering assistant, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Box 755, Milwaukee, Wis.

Merrill L. Garden, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Centerville, Iowa.

Bernard K. Geraghty, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 301 East Main St., Council Grove, Kans.

George W. Gosline, project manager, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 213 Main St., Watsonville, Calif.

Carl V. Gragg, assistant district manager, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 213 Main St., Watsonville, Calif.

John H. Greene, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Hayneville, Ala.

W. W. Hair, Jr., assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 81, Garland, Tex.

Edwin L. Hansen, assistant in agricultural engineering, agricultural engineering department, University of Illinois, Urbana, Ill. *(Continued on page 176)*

"Dirt Farmer" News

"SAVES 10 GALLONS OF GAS A DAY," say Melvin and Arthur Sondreal, of Reynolds, N. D., describing their experience with their new high compression Minneapolis-Moline KTA. Adds Melvin: "Last year I used a big 4-plow tractor. It used about 40 gallons of gasoline a day, running my separator. This year the high compression M-M used only 30 gallons a day and it shows just as much power on the belt. The gasoline is regular grade, containing lead tetraethyl."

George Von Deylen *George Wiemken*

SELL 17 TRACTORS IN 60 DAYS. Von Deylen & Wiemken, tractor dealers of Napoleon, Ohio, who sold only 2 tractors in the same period the year before, say: "We wouldn't have made the sales without the demonstration of high compression performance, proving that it gives a lot more power and uses less fuel in comparison to the amount of work done." Ray Godfried, of the Hixon-Peterson Lumber Co., Monroe, Mich., who sold 23 tractors their first year in the business, says: "There is no competition when you demonstrate high compression. We know that the better performance and better economy of high compression engines are a major factor in our sales success. We expect to double our sales this year."

"OFTEN COVERS 25 ACRES A DAY," says Edwin H. King, (below) of Orient Point, N. Y., speaking of his new high compression Cletrac "E." "It's the fastest working tractor I've owned. It gets all the power out of gasoline—has so much power, in fact, that all hands would rather work it than any of my other tractors."

MODERN FARMING NEEDS THE

Applicants for Membership

(Continued from page 173)

David H. Harker, extension drainage specialist, agricultural extension service, Purdue University, Lafayette, Ind. (Mail) New Agricultural Engineering Building.

R. W. Hautzenroeder, chief engineer, tractor division, The Fate-Root-Heath Co. (Mail) 201 W. 3d St., Mansfield, Ohio.

Earl A. Iliff, superintendent of projects (CCC Camp D-3) Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) CCC Camp D-3, Bancroft, Iowa.

Clark E. Jacoby, drainage engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) 6215 Summit St., Kansas City, Mo.

D. E. Jones, assistant rural electrification extension specialist, North Carolina State College, Raleigh, N. C. (Mail) 318 Ricks Hall, State College Station.

Edwin R. Kinnear, agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Burlington, Vt.

Homer W. Krattly, junior civil engineer, U. S. Engineer Department. (Mail) Box 63, Rockport, Mo.

Edwin A. Krekow, junior civil engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Bancroft, Iowa.

John W. Kuhnel, assistant civil engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Department of agricultural engineering, Purdue University, Lafayette, Ind.

George T. Latimer, CCC drainage camp superintendent, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) CCC Camp D-2-Ill., Gilman, Ill.

Eugene W. McGaan, assistant engineer, (Drainage Camp D-2), Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Camp D-2, Gilman, Ill.

John E. Nelson, camp superintendent, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Camp SCS-3, Wrightstown, N. J.

J. R. Oliver, junior agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 621 N. 1st St., Winterset, Iowa.

John T. Olsen, assistant drainage engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture, Washington, D. C.

James J. Pellett, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Gallupville, N. Y.

Harry E. Reddick, regional conservator, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Santa Paula, Calif.

McLemore Roberts, associate agricultural engineer, Soil Conservation Service. U. S. Department of Agriculture. (Mail) RFD No. 1, Jackson, Tenn.

Daniel E. Salsbery, senior agricultural engineering aide, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 177, Torrington, Wyo.

Richard C. Stewart, camp engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) Cynthiana, Ind.

Ivan W. Weikel, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 170, Condon, Ore.

Charles R. Wood, junior civil engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture. (Mail) 612 N. 2d St, Clear Lake, Iowa.

TRANSFER OF GRADE

Walter D. Hemker, agricultural engineer, rural electrification department, Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. (Junior to Member)

C. N. Hinkle, tractor representative, technical department, Standard Oil Co. (Mail) 644 S. 21st St., Maywood, Ill. (Associate to Member)

John A. Scholten, research engineer, USDA Forest Products Laboratory, Madison, Wis. (Junior to Member)

Student Branch News

Oregon Student Branch

HOWARD FUJII, of Nampa, Idaho, was elected president for the fall term. Carl Chase and Howard Fujii, our representatives to the ASAE annual meeting last June, gave accounts of their trip and of the meeting at Estes Park, at our October meeting.

Carl Chase, of Nampa, Idaho, was elected president for the winter term. H. G. Davis, director of research of the Farm Equipment Institute, addressed the Branch on February 3, giving a review of developments in farm machinery.

C. C. Johnson, director in charge of the agricultural engineering phase of soil conservation work in the Pacific northwest, addressed the Branch on February 24, giving a summary of various papers presented at the winter meeting of the ASAE in Chicago.

Edwin Stastny of Malin, Oregon, was elected president for the spring term. Prof. W. J. Gilmore, head of our agricultural engineering department, at our March meeting gave highlights of his trip to Europe last November and December.

This year we have sent in annual dues to ASAE covering membership for 100 per cent of the students majoring in agricultural engineering at Oregon State College.

Branch members pulled 200 apple trees for a farmer one week-end in January with the diesel tractor, loaned to the school through courtesy of the Caterpillar Tractor Company.

The first of February snow covered the streets to a depth of 22 inches and members of the Branch worked two days and a night, with the tractor and a terracer, cleaning snow off the streets on the campus and in Corvallis.

Members contributed half the articles in the current issue of the Agricultural Journal, which features agricultural engineering.

Plans are under way for the Branch to attend the ASAE annual meeting this coming June, at Urbana, Ill.—*Gerald R. Kubin, Scribe.*

* * *

North Dakota Student Branch

STUDENTS in agricultural engineering at the North Dakota Agricultural College have recently organized a Student Branch of the American Society of Agricultural Engineers. Fourteen are included on the membership roll, Kirk Crawford is president; Frank Sorenson, vice-president; and Phil Hodgson, secretary-treasurer. Prof. H. F. McColly is our faculty adviser. To date, five meetings have been held.

On January 7, J. G. Haney of the International Harvester Company gave an interesting talk on "Soil and Water Conservation in the Northwest." Films were also shown. The meeting was well attended by students, faculty members, and visitors from downtown. At our meeting held on February 11, Prof. McColly discussed the winter meeting of the American Society of Agricultural Engineers, in Chicago last December. On February 25 Leo Holman, extension agricultural engineer, gave an illustrated lecture on "Rural Electrification." Films for this occasion were secured from the Rural Electrification Administration at Washington, D. C. At our last meeting held March 2, Mr. Lynch, of the Goodyear Tire and Rubber Company branch in Fargo, showed films illustrating the use of rubber tires on tractors and implements. Following the showing of the films, Mr. Lynch led a general discussion on agricultural tires.

Plans are being made for more programs in the future, as well as participation in the annual "Engineers Day" on the campus this spring. It is hoped that a real live Branch can be maintained at the North Dakota Agricultural College.—*Kirk Crawford, President.*

* * *

Missouri Student Branch

ON January 12, two motion picture films on the Panama Canal were shown. Officers elected for the second semester were president, Joe Park; vice-president, Vernon Wood; and secretary, treasurer and scribe, Herman J. Hall.

On February 9, films were shown on "The Science of Soil Formation," and "Routes to California." Plans for Branch activities during St. Pat's Week were discussed.

A committee consisting of Joe Park, Norman Teeter, and Charles Timm was appointed at the meeting on February 23 to plan a program for St. Pat's week. Several films furnished by the Minneapolis-Moline Power Implement Company were shown.

At the meeting March 9 a committee consisting of Bob Sydner and J. S. McKibben was appointed to keep a record of club activities and to make a report at the end of the semester. Webb Clark spoke on the artificial curing of hay, and Bill McCreery on the practicability of wind electric plants on Missouri farms.

March 18 and 19 an engineering exhibit was held, in which each department of engineering sponsored an exhibit of laboratory stunts and equipment and industrial machinery, in the new engineering laboratories, during St. Pat's week.

The Agricultural Engineer's exhibit included (1) miniature models of modern farm machinery in motion, (2) the Wooley terracer, (3) a corn planter operated by electric motor, (4) a binder head (slow motion), (5) a modern tractor with attached cultivator, and (6) an electric fence.

At the March 23 meeting two films were shown, "Romance of the Reaper" and "Inconveniences of Farming."—*Herman J. Hall, Scribe.*

Agricultural Engineering Digest

A review of current literature by R. W. Trullinger, senior agricultural engineer, Office of Experiment Stations, U. S. Department of Agriculture.

Air Conditioning by the Sun, *W. P. Green.* Mech. Engin. [New York], 58 (1936), No. 6, pp. 369-371. Studies conducted at the University of Florida on the possibility of using solar energy for air conditioning in Florida are briefly reported.

In order to secure definite information as to how much heat can be expected from a square foot of Florida sunlighted area, a parabolic-trough or cylinder-type heater was built and mounted upon the roof of the engineering shops at the University of Florida. The reflector has a length of 3 ft and a width of 4 ft and is enclosed in a sheet metal case insulated inside with a single thickness of celotex. The reflector material is a thin sheet of nickel-plated zinc. The top of the reflector case is covered with ordinary window glass. The collector is turned about an axis, parallel to the earth's axis of rotation, by a system of weights and is timed by two alarm clock motors so as to be facing the sun continually. At the focus of the reflector inside its case there is a 2-in round iron pipe which has inside of it a 1.25-in pipe. Water circulates by gravity between the two pipes and is heated by the sun's rays which the reflector concentrates upon the pipe. Provision is made for measuring the quantity of water circulating and the temperature rise.

Results obtained during runs in November, 1934 and 1935, showed as high as 128 Btu per square foot per hour of sunshine collected was possible with this simple type of construction. Radiation losses being less will tend to increase this value during the summer, although the increase in the humidity of the air during the summer cuts down the atmospheric transmission of solar energy. Operating temperatures as high as 220 F (degrees Fahrenheit) were readily obtainable, the aforementioned test being run at 210 F. When filled with water and with all outlets closed the steam pressure rose to 50 lb per square-inch-gage, indicating a temperature in the absorber of approximately 300 F. The ratio of the area of sunshine collected (concentration ratio) to the area of the absorbing surface in this collector is approximately 6.5 : 1. Since it is desirable to reach the temperature of 250 F in operation and above 300 F as a maximum, the concentration ratio should be increased to about 11 : 1. This will also increase the operating efficiency of the unit, since the radiating surface of the absorber will be decreased and therefore both radiation and convection losses from this surface cut down.

The requirements for a solar energy refrigeration plant are briefly outlined, it being concluded that a reflector surface collecting 360 sq ft of sunshine per ton of refrigeration is indicated. To take care of losses this should be increased to 400 sq ft.

Provision for storing the heat collected, or a part of it, so that the plant could remain in operation during cloudy periods and for at least 3 hr after sunset will mean the storing of hot water or some other heated medium in sufficient quantities to furnish the reserve heat necessary for efficient operation. Insulated storage tanks will make this feasible. The storage of water at a maximum pressure of 80 lb per square-inch-gage is recommended.

Agricultural Engineering Investigations at the Idaho Station, *H. Beresford.* Idaho Sta. Bul. 220 (1936), pp. 12-16, fig. 1. The progress results are briefly presented of investigations on irrigation, drainage and land development; new types of farm machinery, including the small-size, high-speed, all-crop combine and plow attachments for pea weevil control; methods of utilization of waste and surplus farm products; power and labor utilization in Idaho creameries; dairy barn ventilation; and rural electrification.

Cetane Rating of Diesel Fuels, *P. H. Schweitzer and T. B. Hetzel.* SAE [Soc. Automotive Engin.] Jour., 38 (1936), No. 5, Trans., pp. 206-214, figs. 10. In the testing method described in this paper, a contribution from Pennsylvania State College, the moment of ignition is determined by a mechanism consisting of a diaphragm in the cylinder head, a phonograph pick-up, a short stiff wire transmitting the motion of the diaphragm to the pick-up, a thyratron relay, and a neon lamp protractor. When ignition occurs in the cylinder the flexing velocity of the diaphragm is sufficiently high so that the voltage generated in the coil of the pick-up trips the thyratron tube and permits a high-tension condenser discharge to be sent through the neon lamp, which by its flashes then indicates the time of ignition.

Because of the absence of friction and arcing the action of the pick-up is more regular than that of a bouncing pin. A similar pick-up is used for indicating injection timing. Using this apparatus and the fixed-ignition-lag method, the Diesel fuel testing in the CFR engine has been so simplified that seven to eight fuels can be tested in an hour with a high degree of reproductibility.

Empirical ratings such as aniline point, Diesel index, viscosity-gravity index and viscosity-slope index were applied to 19 fuels and none of them was found to offer a perfect substitute for engine testing. Some can, however, be recommended for approximate rating.

Combustion knock was found to decrease only slightly when the cetane number of the fuel exceeded 55. Cathode-ray oscillograms would indicate that the knock follows the maximum rate of pressure rise more than the ignition lag.

Fertilizer Placement for Cannery Peas, *C. B. Sayre* and *G. A. Cumings.* New York State Sta. Bul. 659 (1936), pp. 30, figs. 9. In cooperative experiments conducted by the station and the U. S. Department of Agriculture and extending over a period of 3 yr it was found that applying fertilizer in contact with pea seed reduces yields, whereas the same amount of fertilizer applied separately from the seed will increase the yield. Since the type of drills used commonly in the State distribute seed and fertilizer at one operation, an attachment for a grain drill was devised by means of which fertilizer and seed may be sown in one operation, but with the fertilizer so placed as not to injure the seed. Illustrations and descriptions of the device are presented so that growers and manufacturers may devise effective machinery.

Based on 1 year's results, the authors report that superphosphate alone produced a more economical gain than an equal amount of phosphoric acid in a 4-16-4 formula. Placement of the fertilizer 2.5 in to the side and 1 in lower than the seed proved particularly effective. When the distance was increased to 3.5 in much of the stimulus was lost. Up to the maximum amount used. fertilizer increments placed to the side of the row increased yields without injury to germination or to the young plants. The residual effects of a heavy application of fertilizer in rows for the crop preceding peas did not result in any inequality in maturity, being apparently offset completely by the application of the fertilizer applied at the side of the pea rows.

The Reactions and Processes Initiated by Light. In Cold Spring Harbor Symposia on Quantitative Biology, III. Cold Spring Harbor, N. Y.: Biol. Lab., 1935, vol. 3, pp. 71-209, 224-9, figs. 59. The following papers presented are of direct interest to botany: Protochlorophyll, by P. Rothemund (pp. 71-79); Behavior of Chlorophyll in Inheritance, by M. Demerec (pp. 80-86); Flourescence and Photodecomposition of the Chlorophylls and Some of Their Derivatives in the Presence of Air, by V. M. Albers and H. V. Knorr (pp. 87-97); Fluorescence and Photodecomposition of the Chlorophylls and Some of Their Derivatives Under Atmospheres of O_2, CO_2, and N_2, by H. V. Knorr and V. M. Albers (pp. 98-107); Toward a More Quantitative Photochemical Study of the Plant Cell's Photosynthetic System, by F. P. Zscheile, Jr. (pp. 108-116); Light Intensity and Carbon Dioxide Concentration as Factors in Photosynthesis of Wheat, by F. S. Brackett (pp. 117-123); Kinetics of Photosynthesis in Chlorella, by W. Arnold (pp. 124-127); The Effect of Intense Light on the Assimilatory Mechanism of Green Plants, and Its Bearing on the Carbon Dioxide Factor, by R. Emerson (pp. 128-137); Photosynthesis of Bacteria, by C. B. van Niel (pp. 138-150); Chemistry of Photosynthesis, by D. Burk and H. Lineweaver (pp. 165-183); The Evolution of Oxygen in the Process of Photosynthesis, be O. L. Inman (pp. 184-190); The Absorption of Radiation by Leaves and Algae, by H. Mestre (pp. 191-209); and Photic Excitation and Phototropism in Single Plant Cells, by E. S. Castle (pp. 224-229).

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THE DISPOSAL OF WASTES FROM MILK PRODUCTS PLANTS, *E. F. Eldridge*. Michigan Sta. Spec. Bul. 272 (1936), pp. 18, figs. 7. Technical information is presented on the elimination of loss of milk solids within the factory and the safe treatment of solids which cannot be economically saved.

It is pointed out that a large share of the milk solids in the wastes of many factories come from the can washer. Usually about 1 lb of milk is lost for every 9 cans washed. Some plants wash as many as 2,000 cans daily, which means a loss of 200 lb of milk. These solid are discharged over a 3 to 4-hr period and would require a stream having a minimum flow of about 55 cu ft per second for satisfactory dilution.

Every washer should be provided with a drip collector. One-half of the milk lost through the can washer may be prevented by collecting the drip; 80 per cent of the remainder may be saved by collecing a short cold water rinse of the cans. The disposal of this rinse may be difficult, and its collection may or may not be practical. In some cases, however, its elimination from the wastes may avoid the cost of building treatment units. In such cases it could be mixed with the drippings and sold or given to the producer for feeding purposes.

The drainage from storage tanks, coolers, churns, vats, and other equipment should be collected in cans and either returned to the product or used for feeding purposes. A cold water rinse of these units may also be collected and used.

Skim milk, buttermilk, and spoiled milk should be considered byproducts and should never be discharged into the factory sewers. These byproducts are highly concentrated, and treatment processes for wastes including them are costly.

Whey and cheese washings are also concentrated and wherever possible should be used either for the manufacture of other products or for feeding. A limited amount of whey and washings may be treated. Considerable effort should be spent in finding an outlet for the whey and as much of the first washings as is possible. These efforts will be amply repaid by the savings in the cost of the treatment required for the factory wastes.

It has been found that the septic process cannot be successfully applied to milk waste, since products are formed by the septic fermentation of milk solids that are much more detrimental to the stream than are the fresh solids. The septic tank, therefore, is not recommended for milk waste disposal.

In the case of small plants located on farms or in sparsely populated districts, irrigation may be used as a means of waste disposal. This method consists of pumping or otherwise spreading the waste onto several acres of land that are kept under constant cultivation. Provision must be made to apply the waste to various portions of the field on alternate days so as to allow the waste to seep ino the soil before a second application is made. Sandy soil is best adapted for this practice. Should odors become obnoxious, chloride of lime, sodium hypochlorite, or liquid chlorine may be applied to the waste before it is pumped to the field. Usually the method is used only during the summer months when stream flows are low. A detailed discussion is presented of the design, construction, and operation of a biological filter for milk waste disposal. This method of disposal consists of the intermittent application of the waste to a filter composed of gravel or crushed stone. The treatment plant necessary for the biological filtration of milk waste consists of three units. These are (1) a holding tank to equalize the waste and to give a longer operating period for the filter, (2) the filter, and (3) a settling tank to remove the suspended material from the waste discharged by the filter.

Information is given on the method of making the 5-day biological oxygen demand determination which is considered the essential test to determine the strength of the wastes and the efficiency of the filter.

THE THIEM METHOD FOR DETERMINING PERMEABILITY OF WATER-BEARING MATERIALS AND ITS APPLICATION TO THE DETERMINAION OF SPECIFIC YIELD, *L. K. Wenzel*. U. S. Geol. Survey, Water-Supply Paper 679-A (1936), pp. IV +-57, pls. 6, figs. 7. This report was prepared in cooperation with the conservation and survey division of the University of Nebraska.

The Thiem method for determining permeability of water-bearing materials consists of pumping a well, or, where the ground water is confined under pressure, allowing the well to flow and observing the decline of the water table or piezometric surface in nearby observation wells. The coefficient of permeability is computed by the formula

$$P = \frac{527.7\, q \log_{10} \dfrac{a_1}{a}}{m\,(s - s_1)}$$

where P is the coefficient of permeability, q the rate of pumping in gallons a minute, a and a_1 respective distances of two observation wells from the pumped well in feet, m for artesian conditions the vertical thickness of the water-bearing bed in feet, m for water-table conditions the average vertical thickness at a_1 and a of the saturated part of the water-bearing bed in feet, and s and s_1 the draw-downs at the two observation wells in feet. This formula is mathematically developed by assuming ideal geologic and ground water conditions, such as a uniform permeability, a uniform thickness of water-bearing bed, a horizontal water table or piezometric surface, and a cone of depression that has reached equilibrium in form. As these conditions are rarely approached, the applicability of the formula and hence of the method has been regarded as questionable.

Two rather elaborate pumping tests were made in 1931 near Grand Island, Nebr., to ascertain the accuracy of the Thiem method and to investigate the possibilities of determining specific yield by a pumping test. The behavior of the ground water was observed over a large area around the pumped wells by measuring the fluctuation of the water table in 81 observation wells during the period of pumping and after pumping was stopped. A study of the data obtained from these tests indicates that the Thiem method is applicable to conditions that are found in nature. However, to obtain consistent and accurate determinations of permeability it is necessary to employ an arbitrary procedure in computing the coefficient The draw-down of the water table at any distance from the discharging well should be taken as the average of the draw-down at that distance up-gradient and down-gradient from the well. In Thiem's formula only results for the draw-down of the water table that are obtained from the part of the cone of depression that has reached approximate equilibrium in form can be used. The part of the cone that has reached approximate equilibrium is determined by frequent measurement of the draw-down during the period of pumping. If the discharging well fails to penetrate through the water-bearing bed, the draw-down of the water table close to the well should not be used because of irregularities in the cone of depression. Moreover, there are usually near the well some changes in the permeability of the water-bearing material resulting from the development of the well. In the first test described in this report the cone of depression reached approximate equilibrium in form out to about 200 ft from the pumped well after 48 hr of pumping and was affected by irregular conditions near the well as far as 40 ft from the well. Hence the draw-downs that were used for computations of permeability were selected from that part of the cone between 40 to 200 ft from the pumped well. In the second test pumping was stopped several times and the cone of depression did not reach approximate equilibrium in form.

Computations were made to determine the specific yield of the water-bearing material from the data obtained in the pumping tests. The results show that the specific yield can be readily determined by this method. Samples of the material were analyzed in the laboratory for specific yield, and the results obtained compared favorably with those determined by the pumping method.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE INDIANA STATION. Indiana Sta. Rpt., 1935, pp. 7-13, figs. 5. The progress results are briefly presented of investigations on mechanical control of the corn borer, cornstalk covering equipment, low corn-cutting equipment, low-pressure pneumatic tires for tractors, combines, and manure spreaders, poultry housing, field ensilage harvesting equipment, erosion control, hay and grain drying, electric brooding of chicks, precooling of fresh fruits in refrigerator cars, codling moth control with electric insect traps, heating apple-washing solution, soil heating with electricity, and sweet potato storage.

PROCESSING FEEDS ON NEBRASKA FARMS, *E. E. Brackett* and *E. B. Lewis*. Nebraska Sta. Bul. 302 (1936), pp. 24, figs. 9. This bulletin reviews work by others on the subject and gives a brief account of the work in feed grinding at the station. Special attention is drawn to the economy of feed grinding and to the mechanical features of grinders best adapted for this purpose.

MOTOR TRUCK TRANSPORTATION IN REATION TO COOPERATIVE FRUIT AND VEGETABLE MARKETING IN MICHIGAN, *G. N. Motts*. Michigan Sta. Quart. Bul., 19 (1936), No. 1, pp. 36-44. A summary is presented of data on the development of truck transportation in connection with cooperative fruit and vegetable marketing in Michigan.

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Effectiveness of Paints as Protective Coatings for Wood, *F. L. Browne*. U. S. Dept. Agr., Forest Serv., Forest Prod. Lab., 1936, pp. 41, pls. 8. Experiments are reported the purpose of which was to consider not only completed paint jobs consisting of two or three coats of one kind of paint but the effect of priming coats alone and of special priming paints followed by finishing coats of ordinary paint.

Moisture-excluding effectiveness was measured by the Forest Products Laboratory method on test specimens of southern yellow pine, Douglas fir, northern white pine, and redwood. The specimens were 3/8 by 4 by 8 in in size with rounded edges and corners. They consisted entirely of clear heartwood. Coatings were applied to all surfaces of the specimens after the wood had been brought to equilibrium at 60 per cent relative humidity and 80 F. Moisture movement through the coatings was measured by the gain in weight of the specimens after transferring them from 60 per cent humidity to a damp air chamber for one week.

The experiments required 1,344 specimens, divided into 21 sets of 16 matched specimens for each of the four species. Nearly all of the primers tested were very low in effectiveness, even when the same paint applied in three coats proved very effective. Moreover there was often no connection between the relative effectiveness of paints as primers alone and their relative effectiveness in two or three coats. As primers alone, the white paints were more effective than the aluminum paints; when, however, the two aluminum primers were covered with two coats of a white paint, such as white lead, the resulting coating was more effective than a 3-coat job with the white paints alone. In other words these aluminum primers, although not particularly effective by themselves, contributed materially to high effectiveness in the completed paint job.

It is considered evident that special primers can be made that will protect wood effectively when used as primers alone and will make good foundations for highly effective and durable coatings when covered by ordinary paints. Aluminum primer does not meet these dual requirements unless the grade of aluminum powder and the nature of the varnish vehicle are much more closely specified than is now customary. If the vehicle is wisely chosen white primers of high effectiveness can also be obtained, but it remains to be determined whether such primers will also have the property of retarding the flaking of paint coatings from conspicuous bands of summerwood that is the principal merit of good aluminum primers for wood.

It was also found that, in general, each successive coat of paint applied to wood improves the effectiveness of the coating against moisture movement, but the increments attributable to each of the successive coats are very unequal. One of the coats, usually the second, seems to achieve the major portion of the final effectiveness.

All specimens representing complete paint jobs were exposed to the weather at 45 deg, facing south at Madison, Wis., and tested for effectiveness and inspected for integrity of the coating at intervals of 6 mo during a total exposure of 3 yr. Visual inspection of the painted specimens at the end of 36 mo showed that the coatings on the backs of nearly all specimens were still glossy, free from fissures, intact, and similar in appearance to young coatings, except that many of the white paints were distinctly yellow, as would be expected from repeated exposure to 97 per cent humidity without subsequent exposure to direct sunlight. It is therefore considered reasonable to suppose that the effectiveness of the coatings on the backs of the specimens remained approximately the same as it was initially. If that assumption is correct the changes in effectiveness of the exposed faces were just twice the changes recorded, and the effectiveness of the exposed face of a specimen at any time $E^F{}_T$ can be computed from the formula $E^F{}_T = 2E_T - E_0$, where E_T and E_0 are the ratings for T months and O months, respectively.

In general, the effectiveness of paints against moisture movement increased during the first few months of exposure to the weather. Nearly all of the coatings tested were more effective at age 6 mo than they were before exposure. Some paints remain near their maximum effectiveness for many months, while others soon pass through the maximum and decrease steadily in effectiveness thereafter. The two control paints, white lead in linseed oil and white lead in Bakelite paint oil, illustrate the two types. White lead in linseed oil declined steadily in effectiveness after its maximum at 6 mo, while white lead in Bakelite paint oil was almost as effective after 36 mo as it was at the beginning. Chalking, checking, and cracking of paint coatings clearly determine which of these two types of behavior shall prevail, but the significant feature of chalking and checking in this connection is not the age at which they first appear but the rate at which they penetrate through the coating.

As priming coats under white lead paint in place of conventional priming, all of the aluminum paints improved both the initial and the maximum effectiveness during subsequent exposure that is characteristic of white lead paint when used for all three coats. From the point of view of protection this long maintenance of effectiveness is more important than increased initial effectiveness. Aluminum in the paste form proved as effective as dry aluminum powder of standard varnish grade when substituted pound for pound in the same vehicles.

Two vehicles, shellac plasticized with castor oil and a nitrocellulose lacquer, proved lacking in durability either as primers for white lead paint or as complete paints. All the other vehicles tested made aluminum primers that greatly improved the maintenance of effectiveness throughout the life of white lead paint. From this point of view there was little basis for preference among the satisfactory vehicles; all left coatings which were more effective after 36 mo than were many good paints initially. Among the satisfactory aluminum primers, however, some proved more successful than others in prolonging the life of the coating on southern yellow pine and Douglas fir.

Raw linseed oil, of course, does not make an aluminum primer of proper consistency for good working properties, but kettle-bodied linseed oil makes a very satisfactory one. As complete paint coatings, all of the satisfactory aluminum paints proved outstandingly durable, both in maintenance of integrity of the coatings on all woods and in maintenance of effectiveness against moisture movement.

In initial and maximum effectiveness all of the paints that contained either white lead or zinc oxide were superior to any of the paints that contained neither white lead nor zinc oxide. The difference is too small to be significant as far as protection of wood is concerned, but is of interest in connection with the theory of the action of pigments in paints. As complete paint coatings, the colored-pigment paints, except red lead, proved lower in initial and maximum effectiveness than the paints that contained white lead or zinc oxide and approximately equal to white paints containing neither white lead nor zinc oxide. Red lead increased in effectiveness up to the eighteenth month, after which its effectiveness decreased rapidly. The litharge paint rapidly lost effectiveness after age 6 mo.

The two chrome yellow paints remained as effective after 36 mo as they were initially, The other colored-pigment paints followed a course of change in effectiveness similar to that of white lead paint but at somewhat slower rates, so that, while less effective than white lead paint at the beginning, they were as effective or a little more effective at the end of 36 mo. In maintenance of the integrity of the coatings all of the colored-pigment paints, except red lead paint, were more durable than any of the white paints. On the whole the colored-pigment paints took longer to develop chalking than did the white paints. The colored-pigment paints, except red lead and litharge paints, developed neither checking nor sigmoid cracking during the test.

As vehicles for all three coats of paint the Bakelite paint oil was superior on the whole to either of the ester gum varnishes when pigmented with white lead, iron oxide, or asbestine. The 75-gal ester gum varnish was more satisfactory than the 33-gal varnish when pigmented with white lead or iron oxide, but not when pigmented with asbestine. Although all three paints made with asbestine were comparatively short-lived (and were transparent), in each case they were more effective and more durable than the corresponding clear vehicles without pigmentation.

Comparison of the results of application by spray gun with the results of brush application of similar paints in other series revealed no significant differences attributable to the method of application.

Agricultural Engineering Investigations at the Arizona Station. Arizona Sta. Rpt. 1935, pp. 19-24, 29, 30. The progress results are briefly presented of investigations on the law with respect to ground water, evaporation rate and duty of water, problems of irrigation enterprises, irrigation water supply of the Safford Valley, and creosoting tamarisk for fence posts.

Soil Erosion Control a Basic Reconstruction Problem. Puerto Rico Sta. Rpt. 1935, pp. 12, 13, figs. 2. This progress report points out that soil erosion has become a very important factor in the agriculture of the island. The heavy compact nature of the soils has resulted in much sheet erosion, as well as gullying. The general conclusion is drawn that accelerated erosion of the agricultural land of the island is being brought about largely by using these lands for purposes or in ways to which they are not naturally adapted. *(Continued on page 192)*

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A. S. T. M. STANDARDS, 1933.—I, METALS. II, NON-METALLIC MATERIALS. Philadelphia: Amer. Soc. Testing Materials, 1933, pts. 1, pp. XX + 1002, pls. 2, figs. 122; 2, pp. XXVII + 1298, pls. [6], figs. 203. The 1933 Book ASTM Standards is published in two parts. Part 1 contains 185 standards, 104 of which relate specifically to ferrous metals, and 70 to nonferrous metals. Part 2 contains 283 standards, of which 60 are standards covering cement, lime, gypsum, concrete, and clay products, and 219 relate to miscellaneous materials, such as coal, timber, paints, petroleum, etc., while 4 apply in general to these materials.

1934 SUPPLEMENT TO BOOK OF A. S. T. M. STANDARDS. Philadelphia: Amer. Soc. Testing Materials, 1934, pp. [7] + 216 figs. 24. This is the first supplement to the 1933 Book of ASTM Standards, noted above, and contains 49 standards adopted or revised on September 1, 1934.

1935 SUPPLEMENT TO BOOK OF A. S. T. M. STANDARDS. Philadelphia: Amer. Soc. Testing Materials, 1935, pp. [7] + 208, figs. 24. This is the second supplement to the 1933 Book of ASTM Standards, noted above, and contains 36 standards adopted or revised on September 3, 1935.

ACTION OF HEAT, LIGHT, AND RADIATIONS ON PLANTS, *P. Chouard*. Compt. Rend. Acad. Agr. France, 22 (1936), No. 4, pp. 133-140. This is a brief statement of the possibilities and the problems of artificial heating or lighting of plants which need further study, including especially the physiology of light effects, particularly ultraviolet light, and the development of efficient processes and systems of artificial lighting and heating in forcing of young plants and in obtaining flowers of a desired character at any given time.

THE PURDUE PLOW TRASH SHIELD, *R. H. Wileman*. Indiana Sta. Circ. 217 (1936), pp. 4, figs. 4. This shield is briefly described and illustrated. It is constructed of sheet metal shaped to form a hood over the top side of the furrow slice as it is turned over. The rear edge of the shield is bent down so that it is perpendicular to the ground surface. This edge is irregular in shape and conforms to the contour of the turning furrow slice. The shield is hinged at the lower front corners and is free to rise and allow any obstruction to pass under it.

DRYING FRUITS AND VEGETABLES, *H. Beresford*. Elect. on the Farm, (1935), No. 9, pp. 10, 11, figs. 2. A fruit and vegetable drier, suited to the needs of the farm family and adapted for operation by electric heat, is briefly described and illustrated.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

ENGINEER who is familiar with agricultural equipment, particularly fruit grading and fruit handling equipment, is wanted by one of the larger manufacturers of such equipment. Anyone interested in this opening should write direct to Secretary, ASAE, St. Joseph, Michigan.

ENGINEERS wanted for service with a state water conservation commission being organized in North Dakota and authorized to investigate and construct irrigation and other conservation projects. These include an office engineer, who will be in direct charge of investigations and design of irrigation projects; an hydrographer and hydrologist who would be expected to make studies of water supply; and a small group of field and office engineers who would work on individual projects. It is anticipated that the program of the commission will have to do largely with small projects, probably to some extent even with the irrigation of individual farms. Applications for these openings should set forth in considerable detail the training and experience of the individuals and should state the minimum salary which they would accept. Considerable experience, preferably in the irrigation field, is essential, and applications should be submitted direct to Mr. E. J. Thomas, State Engineer, Bismarck, North Dakota.